

BRIDGES TO OUR HERITAGE
THE SIGNIFICANCE OF FIVE HISTORIC BRIDGES OVER SINGAPORE RIVER

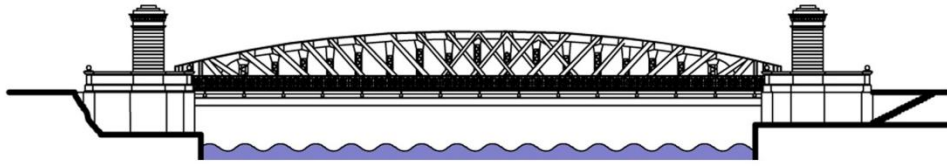
A Dissertation submitted for

MSc in Architectural Conservation,
University of Edinburgh

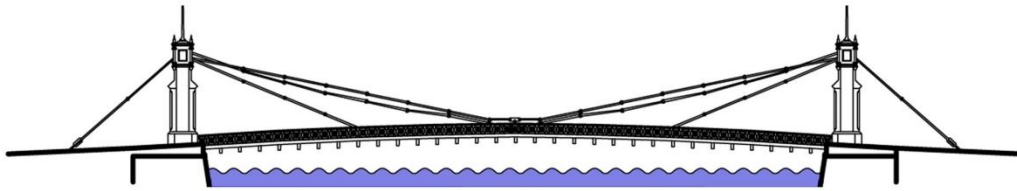
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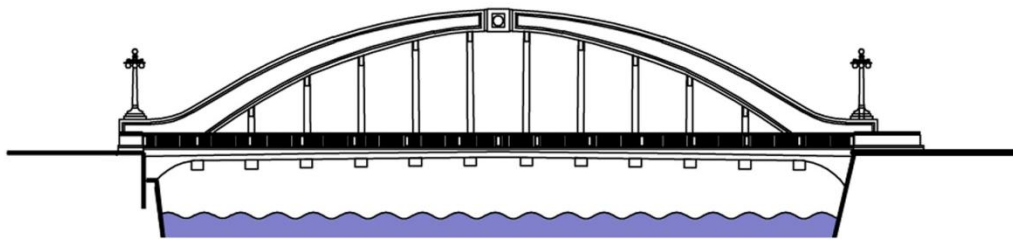
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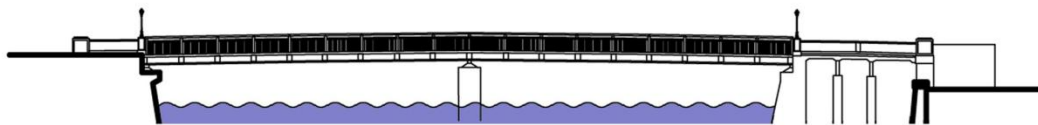
ANDERSON BRIDGE (1910)



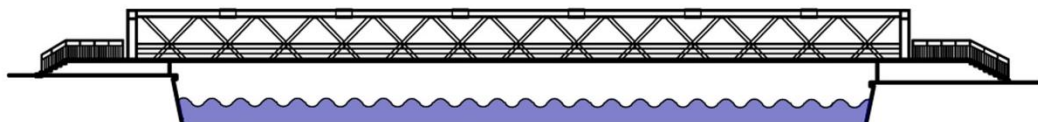
CAVENAGH BRIDGE (1869)



ELGIN BRIDGE (1929)



READ BRIDGE (1931)



ORD BRIDGE (1886)

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ACKNOWLEDGEMENT

This dissertation concludes a most enjoyable and enriching one year studies in Edinburgh College of Art. The great experiences acquired in Edinburgh would never be complete without the camaraderie of friends on the MSc Architectural Conservation Course. This includes Tim, Ricky (Gupreet), Kristy, Nooshin and Daphne.

Apart from the great friendships forged, the course would be incomplete without the hard work put in by the lecturers on this course. Heartfelt thank to Dr Miles Glendinning, Dr Dimitris Theodossopoulos, Ms Diane Watters, Dr Ruxandra-Iulia Stoica and Mr Geoffrey Stell.

I would also like to acknowledge my employer, National Heritage Board (Singapore) for sponsoring my one year studies in Edinburgh. Lastly, this dissertation is dedicated to the authors and interviewees whose knowledge and prior research I am indebted to.

ABSTRACT

The success of conserving historical structures lies in a thorough understanding of its construction, materiality and physical context. This dissertation posits that an understanding of 19th and 20th century technology transfer from Britain to Singapore will help to inform a more sensitive conservation plan for the five historical bridges over Singapore River. This will involve the analysis of the issue at the global, macro and micro scale. Each scale requires different research methods such as using primary and secondary sources and conducting field surveys. The findings from this holistic approach will help form a conservation plan for the five bridges.

CHAPTER 1: INTRODUCTION

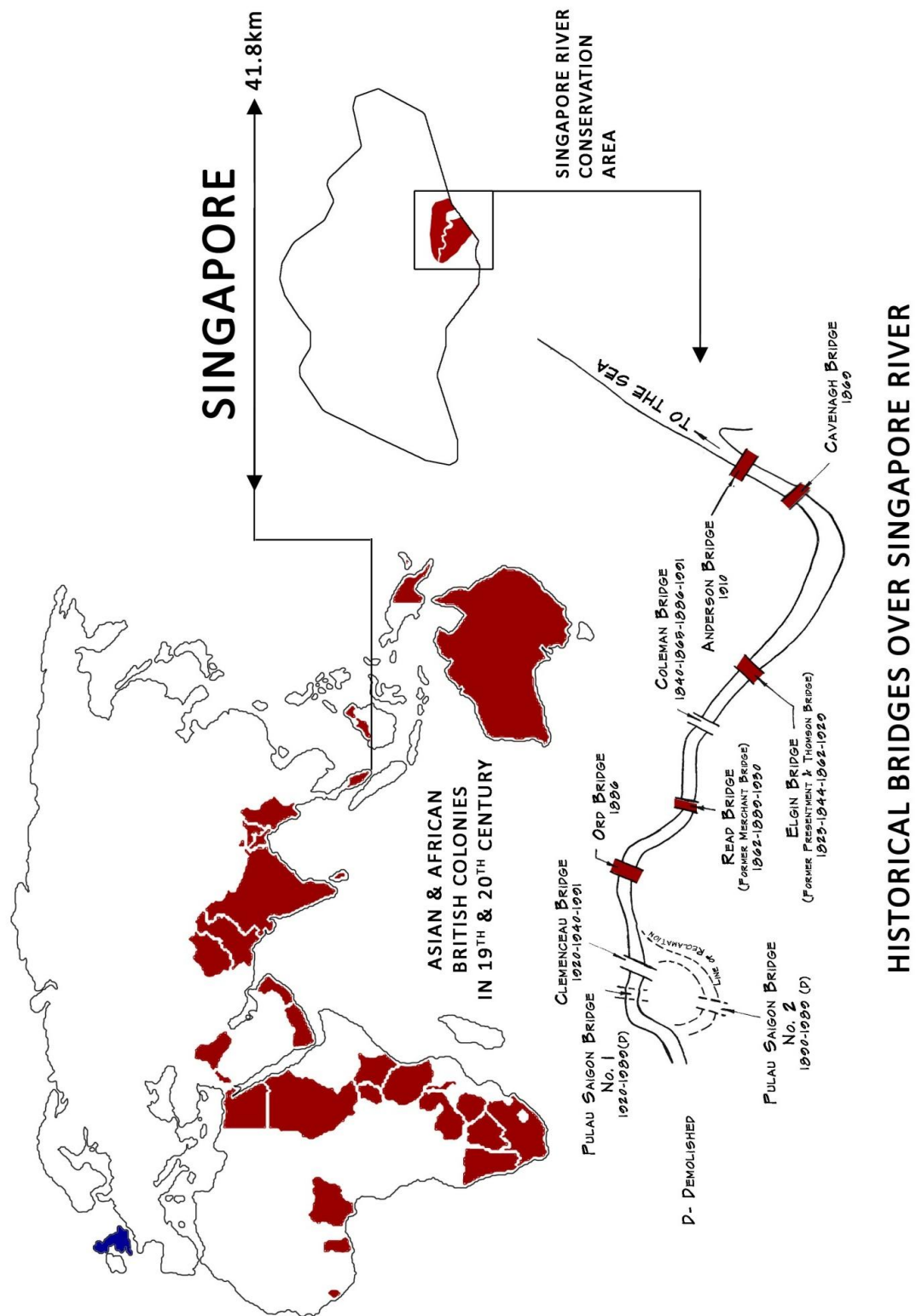
AIMS AND OBJECTIVE

The main objective of this dissertation is to understand the process of technology transfer, specifically bridge construction transfer from Britain to Singapore. Working on three scales of analysis, global, macro and micro, the dissertation aims to draw a relationship between the structural design of these five bridges with tangible factors, such as topology and urban development as well as intangible factors, such as political and economic influences (**Fig 1**). Such a holistic approach which looks at the technology and social context of the historic bridges will help to form a more informed conservation plan.

On a global scale, the paper will attempt to understand how engineering technology from Britain was exported to colonies during the 19th and 20th century. It will also explore whether such colonial technology transfer is a direct process or an indirect process (from Britain to Singapore via another colony, i.e. India).

The macro scale involves understanding Singapore River's urban morphology. This chapter will focus on understanding the significance of the historical bridges to urban development. It will show how the 19th and 20th century bridges fulfilled Singapore's development needs. The chapter will also cover how different factors determine the design and locations of the bridges over Singapore River.

At the micro scale, the dissertation will look at the structural system of these five historical bridges in relation to notable bridges of the same period and system. This chapter will also focus on their load capacities and show how materials and bridge structures evolve to cope with the increased load from motorized vehicles in the 20th century.



HISTORICAL BRIDGES OVER SINGAPORE RIVER

Fig 1: Global, Macro and Micro Scales of Discussion

The concluding chapter will form a hypothetical conservation plan based on the technological and social aspects of the bridges' development. It will show how the bridges could be appreciated beyond its historical and aesthetical qualities.

JUSTIFICATION FOR RESEARCH

In 1819, the British East Indian Company formed the first port settlement around the mouth of Singapore River. The founder, Sir Stamford Raffles divided the settlement into four districts for different occupations and races. In the early days, people largely commuted by boat. However as the settlement expanded inland, bridges were needed to transport people and goods overland.

The earliest of the five historic bridges was constructed in 1869, while the rest were completed between 1886 and 1931. Various structural systems were used in the construction of these bridges. The type of structural system and the materials used were reflective of bridge construction trends during the 19th and 20th century (**Fig 2**).

A summary of their structural system is listed:

1. Cavenagh Bridge (1869) Wrought Iron Cable Stayed Bridge
2. Ord Bridge (1886) Wrought Iron Girder Bridge
3. Anderson Bridge (1910) Steel Bowstring Arch Bridge
4. Elgin Bridge (1929) Reinforced Concrete Bowstring Arch Bridge
5. Read Bridge (1931) Steel Box Girder Bridge

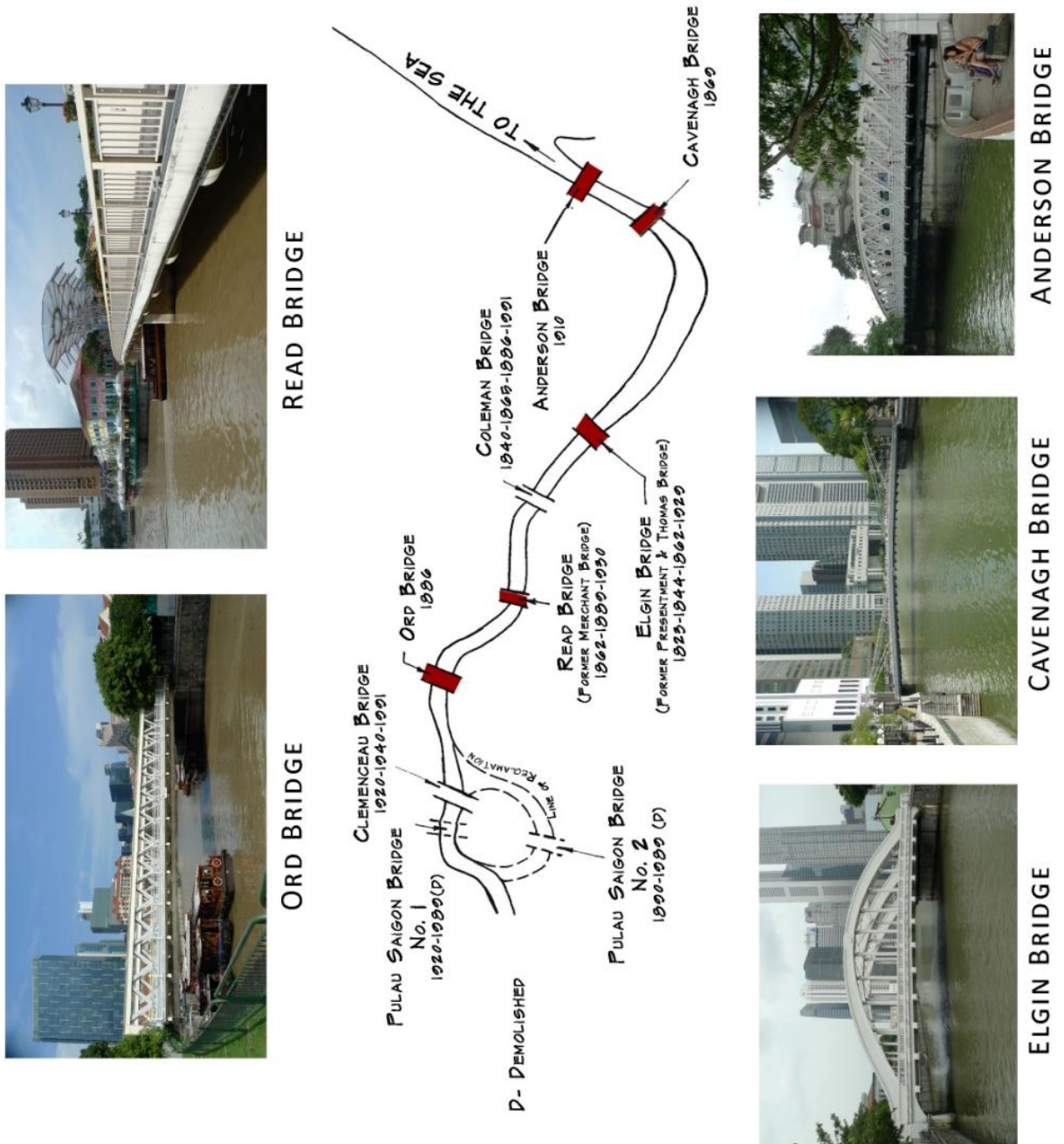


Fig 2: Positions and Designs of Historic Bridges over Singapore River

Literature Review

A number of books and journals have been written on historic bridges, such as Tilly's *Conservation of Bridges*. The central dogma of his book is that bridges must continue to have a function and be conserved to serve that purpose.¹ The author also advocated the safety of bridges as a top priority in conservation. The conservation process hence required knowledge in analysing the structures before deciding on the conservation strategy. Seward's *Understanding Structures* provided a clear understanding of structural design in bridges and how different structural systems can be simplified for analysis.²

The dissertation will focus on the understanding of 19th and 20th century British engineering and its relationship to the five historic bridges. A number of architectural and engineering historians had written about technology transfer during that period. In Rolt's *Victorian Engineering*, one of the chapters described Victorian Britain as the "*Workshop of the World*". New technology was exported worldwide via the Crown Agents and trade shows.³ The economic gains brought about by exporting technology were then elaborated by Hobsbawn.⁴ Authors such as Buchanan⁵ and Headrick⁶ also talked about why engineers ventured to British colonies worldwide.

At a macro level, the significance of the historical bridges to urban development will be explained. This will involve understanding changes in Singapore's urban development for the past two centuries. Home's *Of Planting and Planning* looked at how British town planning was transplanted to its colonies.⁷ This is substantiated by a volume on Singapore's urban planning history written by Yeoh. She examined the social aspects of urban planning from 1880 to 1930 and showed how development was determined by the colonial government and the communities who lived by

¹ Tilly (2002) *Conservation of Bridges*, Highway Agency, London, p13

² Seward (2003) *Understanding Structures*, Palgrave Macmillan, Hampshire

³ Rolt (1970) *Victorian Engineering*, The History Press, Gloucester, pp84-111

⁴ Hobsbawn (1968) *Industry and Empire*, Penguin, London

⁵ Buchanan (1986) *The Diaspora of British Engineering, Technology and Culture*, Vol 27(3) pp501-524

⁶ Headrick (1990) *The Tentacles of Progress*, Oxford University Press, Oxford

⁷ Home (1996) *Of Planting and Planning*, Routledge, London

Singapore River.⁸ Both Home and Yeoh did not specifically examine the role of technology transfer in colonial urban development. It left a significant gap of knowledge which this dissertation will attempt to answer: why were the five historical bridges significant to urban developments in the 19th and 20th century.

Most information from the government only focused on the urban planning of Singapore River after independence. These include *Urban Redevelopment Authority's Development Plans*⁹ and *Planning Reports*¹⁰. In contrast, Dobbs' *Singapore River: A Social History* gave a broad overview of Singapore River's development from 1819 to 2005.¹¹

The micro scale will look at the history of the bridges, which had been extensively researched by Tyers¹², Berry¹³, Hon and Wan¹⁴. These sources have a good collection of photographs and paintings of the bridges at different periods. These are useful in understanding how the bridges relate to the original physical context. Hon's *Tidal Fortunes* focused on the documentation of cleaning Singapore River and the transformation of Singapore River from a working river to a tourist attraction in the 1980s¹⁵. It marked an important period where policy makers started to realise the historic and tourism potential of the five bridges.

⁸ Yeoh (2003) *Contesting Spaces In Colonial Singapore*, Singapore University Press, Singapore

⁹ URA (1992) *Singapore River: Development Guide Plan*

¹⁰ URA (1994) *Singapore River planning area: Planning Report 1994*

¹¹ Dobbs (2003) *The Singapore River: a social history 1819-2002*, Singapore University Press

¹² Tyers (1976) *Singapore Then and Now*, University Education Press

¹³ Berry (1982), *Singapore's River: A Living Legacy*, Eastern Universities Press

¹⁴ Wan (2009) *Heritage Places of Singapore*, Marshall Cavendish Editions

¹⁵ Hon (1987) *Tidal Fortunes*, Landmark Books, Singapore pp41-101

RESEARCH METHODOLOGIES

The dissertation will involve the use of existing literature and field surveys to understand the bridge structures and to form a conservation plan. The three scales of discussion will require a qualitative approach to analyse how conservation can be enhanced with by integrating technology and social aspects of the bridges.

The technology transfer from Britain to Singapore will be discussed at the global scale. It will show how the import of new technology is influenced by different agencies. Next, the macro scale will highlight the social importance of the bridges in the urban development of Singapore River. This part of the dissertation will specifically focus on analysing the impact of urban development on the bridges and vice versa. The micro scale involved conducting fieldworks to understand the structural designs and the materials of the bridges. The measured drawings of the bridges will serve as an important means of relating the structures with the loading capacities.

The main techniques used for this dissertation include referencing primary and secondary sources and conducting field surveys. Primary sources include cadastral maps, planning guidelines, development plans and other government records in different time periods. Secondary sources are based on books and journal articles. Using both types of sources provide a comprehensive understanding of the city and bridges. Field surveys will then be used to elaborate on this knowledge and to help overturn wrong facts repeated in various historical sources. The surveys will also include analysing the structure and the height clearance under the bridges. This will help in understanding how the construction and design of the bridges affect river traffic.

Based on the points listed above, the dissertation is expected to contribute to a deeper understanding in the conservation of historic bridges in Singapore. No prior studies on the conservation of the bridges had been conducted. This dissertation will hence serve as a starting point for further research in technology transfer to colonial Singapore.

CHAPTER 2: GLOBAL

THE PROCESS OF BRIDGE TECHNOLOGY TRANSFER

A commemorative plaque on Elgin Bridge states:

“The first iron bridge in Singapore was built in 1862 and was named after Lord James Bruce, the eighth Earl of Elgin who served as the Governor-General of India. The bridge was prefabricated in England and shipped via Calcutta. It was dismantled in 1925 and the new concrete bridge opened to traffic in 1929. Special features include medallions of the Singapore Lion and the elegant cast iron lamps designed by the famous Italian sculptor Rudolfo Nolli.”

The deceptively simple description of the bridge underlines the generally prevalent approach towards the appreciation of monuments. The main emphasis is placed on the social history and aesthetic appeal of the structure. However the technological aspect of the structure is overlooked. The significance of the five historical bridges could be better appreciated with a deeper understanding of the technology transfer from United Kingdom to Singapore in the 19th and 20th century. This process should not be simply seen as a utilitarian act of importing technology to develop the city. Instead, the motivation to commission and build the five bridges should be seen as an intrinsic part of the politics and economy of the colonial city and its importance on the Britain-India-China shipping route.

This chapter will focus on two aspects. Firstly, it will discuss the socio- economic context in which the bridges were imported to Singapore; secondly, it will determine whether colonial technology transfer was a direct process or, as the description of Elgin Bridge mentioned, an indirect process through other colonies.

According to historian Headrick, the transfer of technology is a complex process whereby two distinct modes of action occurred consecutively. It involved not just the export of the bridges but also transferring the expertise required to assemble and maintain them. The technology transfer would thus require the exporting country to impart knowledge and skills for the importer to maintain the technology.¹⁶ Headricks differentiated the two actions as “*Geographic Relocation*” and “*Cultural Diffusion*” respectively.

Utilising Headrick’s framework, the chapter will look at the key factors involved in the geographical relocation of the bridges from Britain and other colonies to Singapore as well as the agencies importing and maintaining the bridges in the 19th and 20th century.

FROM TRADING PORT TO CROWN COLONY: 1819-1867

In parts of Middle East, Africa and the Far East, British colonialism was driven by trade and the security of India. Beginning in the 19th century, India occupied the strategic centre of the British Empire’s trade in Asia. Through the East India Company, India provided most of the raw materials needed for the Industrial Revolution in Britain.¹⁷ Moreover, as the forerunner of British colonies in Asia, India developed its trade decades earlier than other colonies. By 1860, India’s trade with Britain was the sum of British trade with China, South Africa and Australia combined.¹⁸ Due to its significance, the East India Company established colonies and trading ports along the Britain-India trading route to protect it (**Fig 3**). These colonies included South Africa, Egypt, Malaya, Singapore and Burma. The establishment of Singapore was thus driven by its subordinate relationship to India and the need to provide opportunities for British enterprises in South East Asia.

¹⁶ Headrick (1988) *The Tentacles of Progress, Technology Transfer in the Age of Imperialism 1850-1940*, Oxford University Press, New York, p9

¹⁷ Benians (1959) *The Empire in the New Age 1870-1919* in *The Cambridge History of the British Empire*, Cambridge University Press, Cambridge, p4

¹⁸ Headrick (1988) *The Tentacles of Progress, Technology Transfer in the Age of Imperialism 1850-1940*, Oxford University Press, New York, p14

In 1818, the founder of Singapore, Sir Stamford Raffles arrived in Bencool, Indonesia. As the Governor-General of the settlement, he was appalled to find several Dutch colonies in Sumatra and Malacca. As Raffles wrote, *"The Dutch possess the only pass through which ships must sail into the Archipelago. The British have now not an inch of ground to stand upon between the Cape of Good Hope and China, nor a single friendly port at which they can water."*¹⁹ Raffles started negotiating with local Malay rulers for permission to establish a trading port in Singapore. With the founding of the trading port on 19 February 1819, Raffles broke the Dutch stronghold in Malaya and Indonesia.

The Anglo-Dutch Treaty of 1824 saw Britain exchanging its trading ports in Sumatra for Dutch ones in the Malay Peninsula.²⁰ The East India Company then united Singapore, Penang and Malacca to form the Presidency of the Straits Settlements in 1826 to promote trade along the Britain-India-China route. In 1833, the East India Company lost its trade monopoly with China. The Straits Settlements, which was established to protect and serve this sea trading route, was affected badly. The Presidency of the Straits Settlement was reduced to a Residency under Bengal.²¹ With the loss of a major trading partner and a source of revenue, the India Office tried to avoid financial deficit by reducing monetary support to Singapore. This policy of non intervention in the Straits Settlement persisted throughout Indian rule from 1830 to 1852.²²

A breakthrough was achieved in 1867 when a group of Straits businessmen successfully petitioned the Colonial Office in Britain to establish Singapore as a Crown colony. The transfer was made possible by lobbying Members of Parliament, Commerce Chambers and other commercial bodies. The future commercial viability of Singapore had to be established before the British government was willing to take over the colony.²³

¹⁹ Turnbull (1977) A History of Singapore 1819-1975, Oxford University Press, Kuala Lumpur, p7

²⁰ Ricklefs (1982) A Modern History of Indonesia, MacMillan, New York, pp111-2

²¹ Turnbull (1977) A History of Singapore 1819-1975, Oxford University Press, Kuala Lumpur, p34

²² ibid

²³ Turnbull (1977) A History of Singapore 1819-1975, Oxford University Press, Kuala Lumpur, pp72-75

Development occurred rapidly after Singapore's establishment as a Crown Colony on 1 April 1867. Three events provided the impetus for developing Singapore. Firstly the opening of Suez Canal in 1869 established Singapore as a key British port for European ships to get fuel and water en-route to China and India.²⁴ Secondly, by late 1860s, cargo ships were much more efficient due to advancements in steamship technology. The iron hull, the surface condenser and the compound engine allowed the cargo ship to carry more goods, operate with less coal and sail faster (**Fig 4**).²⁵ As a result of higher shipping and trading volume in Singapore, commercial and military infrastructure was built up rapidly. The construction of key infrastructure such as harbours and roads was essential for trade along Singapore River.²⁶ In turn, the revenue generated from shipping and trade was used to improve public works.

Riding on the wave of prosperity after the opening of Suez Canal, the five historical bridges over Singapore River were constructed between 1868 and 1929 during the Crown Colony period. It signified the importance of overland infrastructure for transporting goods and people. Collectively, the bridges represented a unique part of Singapore's history during the 19th and 20th century. The chronology of events from Singapore's establishment in 1819 up to its establishment as a Crown colony in 1867 showed the vulnerability of the colony to the effects of global events. Even during its age of prosperity as a Crown colony, the development of Singapore continued to be affected by global events.

²⁴ Turnbull (1977) *A History of Singapore 1819-1975*, Oxford University Press, Kuala Lumpur, p78

²⁵ Headrick (1988) *The Tentacles of Progress, Technology Transfer in the Age of Imperialism 1850-1940*, Oxford University Press, New York, p26

²⁶ Buchanan (1986) *The Diaspora of British Engineering in Technology and Culture*, Vol. 27 No. 3 (Jul 1986), pp513-4

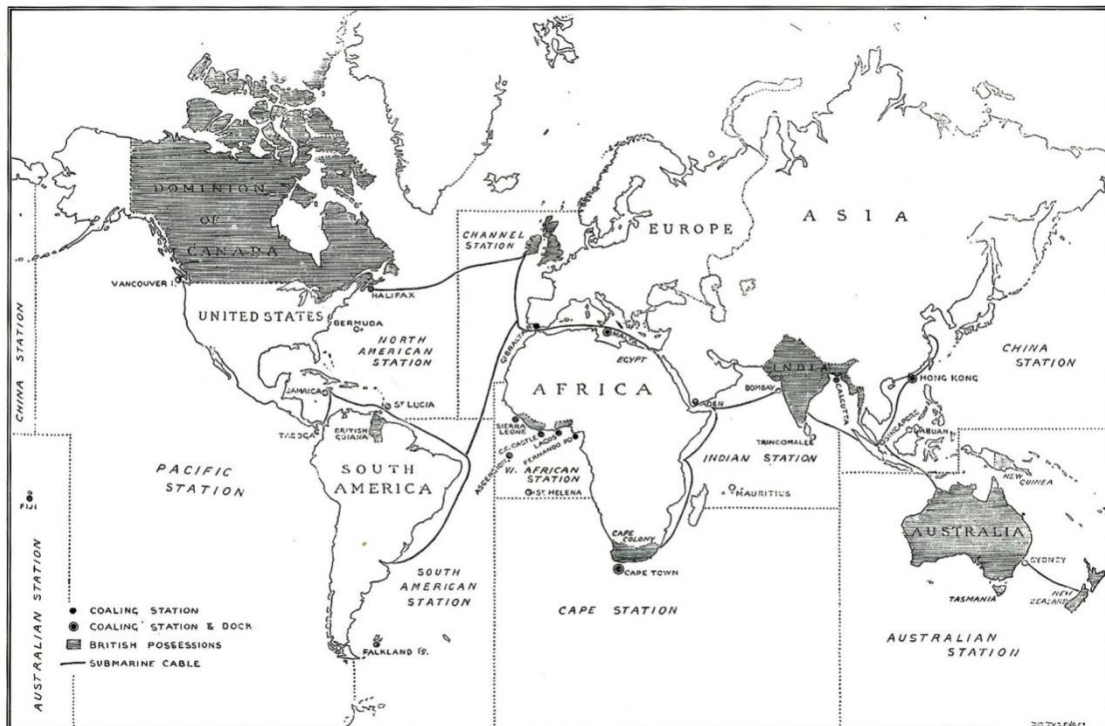


Fig 3: Trading Ports, Dockyards and Coaling Stations of the British Empire



Fig 4: Steamships in Keppel Harbour (1890)

A TRIPARTITE ADMINISTRATION OF SINGAPORE'S DEVELOPMENT

Within the British Empire, there were two types of colonies: the self-governing colonies and the dependent colonies. Crown colonies like Ceylon, India and Malaya belonged to the latter category. The British government ruled the colony through the colonial government appointed by the Colonial Office. The Governor and the colonial civil servants took charge of the colony's administration. The drafting of legislation was handled by the Legislative Council which comprised of civil servants and British businessmen.²⁷

In Britain, the Treasury handled the economic activities concerning the Straits Settlements. It drafted the economic policies and determined the colonial government's budget and expenditure. The Office of the Crown Agents, a quasi government agency, was designated to represent the commercial and economic interests of the colony in Britain.²⁸

The responsibility of developing Singapore and the rest of the Straits Settlements thus lies in the hands of these three groups of people with different agendas and objectives. The geographical distances between Britain and Singapore resulted in lengthy communications amongst the three groups. This caused long delays for public works. Furthermore, the colonial government had to finance its own public projects frequently as the Treasury attempted to reduce public expenditure.²⁹ As a result, infrastructure developments were often paid by the colonial government and businessmen. The construction of Merchant Bridge in 1862, for example, was paid by the government and businesses around the bridge.³⁰ A further examination of the functions and connections among the three groups will enable us to understand how these stakeholders were involved in the construction of the five historical bridges.

²⁷ Hall (1937) *The Colonial Office*, Royal Empire Society, London, pp92-3

²⁸ Sunderland (2004) *Managing the British Empire, The Crown Agents, 1833-1914*, The Royal Historic Society, Wiltshire, pp1-2

²⁹ Home (1997) *Of Planting and Planning*, E& FN Spon, London, p3

³⁰ Read Bridge, 21 June 1862, *The Straits Times*, p1

THE COLONIAL OFFICE

A study conducted on the Colonial Office in the 1930s described it as a light-handed and benevolent ruler of colonies. Its purview covered “anything which concerned the welfare of the colonies”.³¹ The Office dealt with duties ranging from the drafting of constitutions, to the eradication of vices such as “*gambling and prostitution in Hong Kong and Malaya.*”³² Yet despite its best efforts, the department was widely condemned by the colonial government for being unconcerned about Singapore’s development. When the first Crown Colony Governor, Sir Harry Ord, wrote to the office in 1867 seeking funds to build military installations, he was given an indifferent reply, “*There is scarcely any colony under the English dominion in which the Crown and the control of the government is so dispensable as in the Straits Settlements.*”³³

The example highlighted the conundrum posed by the Colonial Office in its dealings with colonies. On one hand, the Colonial Office wanted to increase the Britain’s dominance in international trade by having many colonies; on the other hand, the development of colonies were largely ignored to minimise the amount of expenditure the British government had to incur.³⁴ The colonial government had to raise funds for public works through taxes, selling lands and operating public transport. During both Indian and British rule, there were many instances where the funds required for building new roads and bridges were borne by businessmen and the Colonial Government. When a new bridge was needed, funds were raised from businesses around the vicinity. Each merchant would pledge an amount and the balance would be paid by the Colonial Government. The first Elgin Bridge (1842), the first Read Bridge (1862) and Ord Bridge (1887) were constructed through such public subscriptions.³⁵

³¹ Hall (1937) The Colonial Office, Royal Empire Society, London, p25

³² *ibid*

³³ COD 2, No 71, quoted in Turnbull (1977) A History of Singapore 1819-1975, Oxford University Press, Kuala Lumpur, p81

³⁴ Sunderland (2004) Managing the British Empire, The Crown Agents, 1833-1914, The Royal Historic Society, Wiltshire, p15

³⁵ Elgin Bridge, 4 Oct 1862, The Straits Overland Journal, p1

Even though much of the public infrastructure was built without the Colonial Office's support, it was hardly absent during the colony's development. The department took an active role in spearheading and funding high-profile infrastructure developments such as the construction of the Singapore-Kranji Railway in 1903 and the construction of the New Singapore Harbour in 1914.³⁶ Such major projects were "geo-politically motivated" as there were numerous benefits to be derived from them.³⁷ The Colonial Office could maintain control over major developments in the colony and be seen favourably by both colonial and British residents. Most importantly, the development of major public infrastructure, such as harbours and railways, would encourage the import of more British technology, thereby creating jobs and revenue for Britain.

The Colonial Office saw infrastructure development in the Crown Colony as a double edged sword. A well-developed, modernised colony would generate its own income and depended less on the British Treasury. At the same time, the availability of construction projects in Singapore would attract British engineers to work there. This influx of engineering expertise played a crucial role in the construction of new infrastructure and the dissemination of engineering knowledge to the local population.

THE CROWN AGENTS AND THE CONSULTING ENGINEERS

In a 1912 report, the head of *the Office of the Crown Agents for the Colonies*, Sir Ernest Blake described the organisation as "*absolutely unique*".³⁸ The Crown Agents operated as part of the Colonial Office and were appointed by the Secretary of State, however the office was self-sufficient. It managed its own salaries and retained the right to recruit and dismiss staff without approval of the Colonial Office. Most ironically, although the Crown Agents worked for the colonies, there were

³⁶ Makepeace, et al (1921) *One Hundred Years of Singapore*, John Murray, London, pp11-5

³⁷ Anderson (2011) *Colonial Connections and Consulting Engineers, 1850-1914*, *Engineering History and Heritage*, Vol. 164, Issue EH4, pp201-2

³⁸ The Crown Agents, *The Straits Times*, 5 Oct 1912, p12

numerous reports from the Colonial Government accusing the Crown Agents of unsatisfactory services and exorbitant prices.³⁹

The origins of the Crown Agents could be traced back to the early days of the empire. Colonies realised it was important to have an agent in London to purchase British goods for them at reasonable prices. This role was taken up by clerks in the Colonial Office before the Colonial Office appointed two autonomous Crown Agents to oversee the commercial activities of the Crown colonies.⁴⁰ The Crown Agents maintained a high degree of economic control over the Colonial Government. All non-local products were purchased through them. Moreover, the Crown colonies could only raise loans for public works through them. Public infrastructure contracts were also made on behalf of the colonies by Crown Agents in Britain.⁴¹ Crown Agent was therefore a crucial link between the Colonial Government and the suppliers of goods and services in Britain.

As an independent organisation, the survival of the Crown Agents was dependent on the satisfaction of the Crown colonies with the agents' services.⁴² Colonies could lodge complaints to the Colonial Office or refuse to pay for goods and loans if they are not satisfied with the services offered. As a result, public contracts for the colonies were seldom awarded by tender. The Crown Agents believed the lowest priced goods were more likely to be of low quality.⁴³ Instead, invitations were sent out to firms on the Agents' list of suitable companies. The list was tightly controlled and orders tended to be awarded to a small coterie of suppliers that produced quality goods.⁴⁴

A similar approach was taken in the selection of consulting engineers for infrastructure works in the colony. As the Colonial Office personally oversaw major infrastructure works in colonies,

³⁹ For example, see 29 June 1878 Straits Times Overland Journal, p3 and 21 Aug 1907 The Straits Times, p7

⁴⁰ Hall (1937) The Colonial Office, Royal Empire Society, London, pp42-43

⁴¹ *ibid*

⁴² Sunderland (2004) Managing the British Empire, The Crown Agents, 1833-1914, The Royal Historic Society, Wiltshire, p20

⁴³ Sunderland (2004) Managing the British Empire, The Crown Agents, 1833-1914, The Royal Historic Society, Wiltshire, p53

⁴⁴ Sunderland (2004) Managing the British Empire, The Crown Agents, 1833-1914, The Royal Historic Society, Wiltshire, p56

the Crown Agents favoured employing well-established engineers to provide good consulting services.⁴⁵ The expensive fee charged by consulting engineers was not a primary concern to the Crown Agent as they were, often grudgingly, paid for by the colony.⁴⁶

The term Consulting Engineers, according to Anderson, was also “contested and ambiguous”.⁴⁷ It was used to loosely denote engineers who practised independently and was not in the employment of any contractors. They received fees for their consultations in a public project and were not allowed to participate in its construction. However in many cases, even though the consulting engineers could not directly participate in the construction, the project would invariably be awarded to firms affiliated to the engineer.

The Crown Agents relied heavily on a small group of prominent engineers based in London to provide consultation services. Although their fees were high, these engineers had a good reputation and a track record of handling public projects of similar scale. More importantly, the engineers had a long-standing relationship with the Crown Agents and would not risk upsetting it by providing sub-standard services.⁴⁸

Prominent consulting engineers who had worked on Singapore projects included Sir John Jackson, a well known bridge builder. He had constructed the Manchester Ship Canal and the foundation works for the Tower Bridge in London before taking on consulting works for breakwaters constructed in Singapore between 1909 and 1919.⁴⁹ The opportunities available in the Straits Settlements prompted him to establish a branch of his engineering firm, Sir John Jackson Ltd, in

⁴⁵ Anderson (2011) *Colonial Connections and Consulting Engineers, 1850-1914*, Engineering History and Heritage, Vol. 164, Issue EH4, p205

⁴⁶ During the construction of the Singapore-Kranji Railway, there were several reports criticizing the expensive fees charged by the consulting engineers (Untitled, 21 Aug 1907, *Straits Times*, p7) and the Crown Agents for increasing the price of construction (Crown Agents’ Ways, 6 April 1909, *Straits Overland Journal*, p8)

⁴⁷ Anderson (2011) *Colonial Connections and Consulting Engineers, 1850-1914*, Engineering History and Heritage, Vol. 164, Issue EH4, p201

⁴⁸ Sunderland (2004) *Managing the British Empire, The Crown Agents, 1833-1914*, Royal Historic Society, Wiltshire, p109

⁴⁹ Untitled, *The Singapore Free Press and Mercantile Advertiser*, 17 December 1919, Page 12

Singapore. The firm received several commissions from consulting engineers and remained active in Singapore until World War II.⁵⁰

The system of Crown Agents was criticised heavily. The Crown Agents' Office was initially set up to prevent nepotism practices in the Colonial Government. These included awarding public contracts to preferred colonial and foreign firms and preventing British firms from tendering in colonial projects. Ironically, through its obsession of providing high quality goods, the Crown Agents gave preference to a small group of British firms. The trade cartel created by the Crown Agents thus increased the prices of goods and services and discriminated against colonial businessmen. The difference in prices was so great that a Singapore newspaper remarked how *"easy it was to compare the ordinary merchant's prices with the Crown Agents' prices and to find (the difference) instructive"*.⁵¹

THE COLONIAL GOVERNMENT AND ITS STATUTORY BODIES

As the capital of the Straits Settlements, Singapore's infrastructure development exceeded those of Penang and Malacca.⁵² A Public Works Department report published in 1906 listed the infrastructure expenditure of Singapore as \$1,066,769 for 1905. It was more than half of the total \$2,046,663 budget allocated for the three colonies.⁵³ A well developed road system and port infrastructure not only contributed to the efficiency of trade and transportation, it also formed a good impression for the Straits Settlements' capital. The Colonial Government spared no effort in public works during the Crown Colony period and hence had the greatest influence in the *"geographic relocation"* of technology from Britain to Singapore. In addition, through its Public Works Department, it was also the main *"culture diffuser"* of new British technology.

⁵⁰ War Claims Company, The Straits Times, 12 May 1949, p10

⁵¹ Crown Agents, Consulting Engineers and Railways, The Straits Times, 21 Aug 1907, p7

⁵² Turnbull (1977) A History of Singapore 1819-1975, Oxford University Press, Kuala Lumpur, p36

⁵³ The Public Works Department, Eastern Daily Mail, 28 Aug 1906, p2

As a residency under Indian rule from 1826 to 1867, Singapore's infrastructure development was severely curtailed. Newspaper reports described how the *"main streets were frequently flooded at high tide and was plagued by stray dogs. The city's refuse was thrown into the swamps and the roads were littered with garbage."*⁵⁴ The city fell into a dismal state as neither the East India Company nor the India Office was willing to give Singapore any monetary support due to its free trade policies.⁵⁵ The India Office also *"refused to build new bridges or to repair the two timber bridges which could not cope with traffic and were in a dangerous state"*.⁵⁶ As the bridges were important to overland traffic, the Colonial Government under Governor William Cavenagh paid for the cost of erecting the first iron bridge over Singapore River. It raised the funds through public subscription and a loan from the Oriental Bank.⁵⁷ The iron girder bridge was manufactured in England before shipping over to Singapore. It was unlikely to have passed through India since the India Government had been unconcerned with infrastructure development in the colony.

Transitioning from Indian to British Rule, changes occurred within the executive and judiciary arm of the colonial government. The Governor ruled with the help of the expanded Executive and Legislative Councils. The Executive Council consisted of the Governor, the Colonial Secretary and civil servants from Britain. The legislative arm comprised of members from the executive arm, the Chief Justice and four non-officials nominated by the Governor. **(Fig 5)** Before 1880s, ad-hoc committees were appointed from these two arms wherever new public works were needed. The rapid development of the Straits Settlement led to the establishment of a Municipality to cope with the infrastructure development. The first Municipal Ordinance was passed in 1888 to establish the Municipal Council.⁵⁸ Key appointment-holders included the Municipal Chairman, the secretary and the engineer. **(Fig 6)** As the colony developed, there were more engineering works

⁵⁴ Turnbull (1977) A History of Singapore 1819-1975, Oxford University Press, Kuala Lumpur, p36

⁵⁵ Makepeace, et al (1921) One Hundred Years of Singapore Vol I, John Murray, London, pp84-85

⁵⁶ Turnbull (1977) A History of Singapore 1819-1975, Oxford University Press, Kuala Lumpur, p36

⁵⁷ Municipal Council, The Straits Times, 14 June 1862, p1

⁵⁸ Makepeace, et al (1921) One Hundred Years of Singapore Vol I, John Murray, London, p320

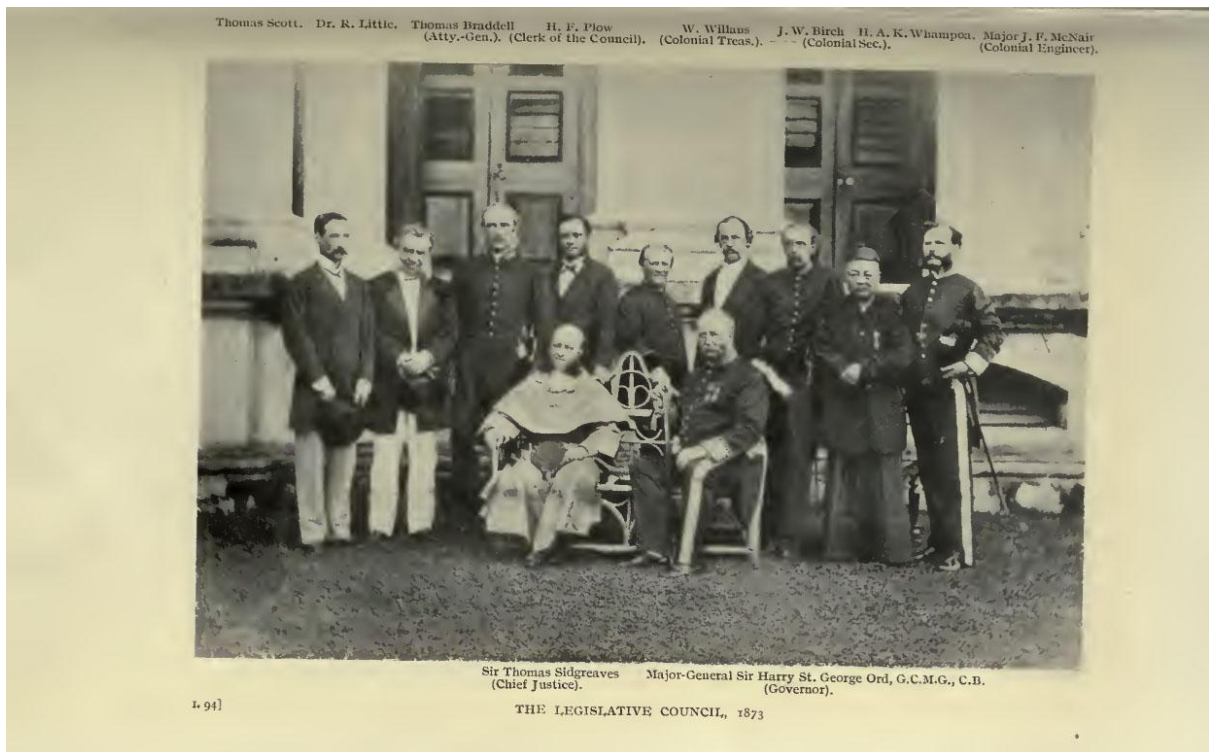


Fig 5: First Crown Colony Legislative Council (1873)



Fig 6: Municipal Officers (1915)

which required supervision. Four Municipal Engineers in charge of roads, gas and electricity, waterworks and lighting respectively, were employed in the 1920s.

The Public Works Department oversaw the construction of infrastructure and civil buildings in the Straits Settlements. The department first started in 1856 under Indian rule. Three year prior to that, the Governor-General of India, Lord Dalhousie, established India's Department of Public Works to supervise the canal and road construction projects in the sub-continent.⁵⁹ This concept of a supervisory body for public works was implemented in the Straits Settlement to better manage the various projects happening in the three separate colonies. In 1872, the position "*Superintendent of Public Works*" was changed to "*Colonial Engineer*" to reflect the expansion of duties from a supervisory role to one which required the engineer to design structures, conduct land surveys and advise on infrastructure developments in the colony.

The Colonial Engineer and the Municipal engineers had related but separate work scopes. The Colonial Engineer and the Public Work Department worked for the Colonial Government. They were in charge of overseeing public works within Singapore and the Straits Settlements. The Municipal Engineers, on the other hand, were only involved in public works within the Municipality of Singapore. Collectively, the two organisations were instrumental in transferring new technology from Britain to Singapore. In addition, they helped to disseminate the skills of construction and maintenance to the non-European employees of Public Works Department and Municipality.

⁵⁹ Headrick (1988) *The Tentacles of Progress, Technology Transfer in the Age of Imperialism 1850-1940*, Oxford University Press, New York, p61

SYMBOLISM OF THE HISTORIC BRIDGES

Apart from the functional utility of the historic bridges, the five bridges were also used to commemorate the “*exceptional contributions of individuals to the colony*”.⁶⁰ Due to the high manufacturing and import cost, the iron and steel bridges were seen as symbols of prestige. Of the five historic bridges, three were named after former governors of colonial Singapore. These are Anderson, Cavenagh and Ord Bridges.⁶¹ Read Bridge was named after William H Read, a prominent Scottish businessman and a longstanding member and president of the Legislative Council.⁶²

The first Elgin Bridge constructed in 1862, was named after Lord Elgin, the Governor-general of India from 1861 to 1863.⁶³ Although he did not contribute directly to the colony, the Colonial Government’s decision to name the bridge after him was a shrewd political move. As Singapore was placed under Bengal rule from 1830 to 1867, the Colonial Government was unable to petition Lord Elgin directly. Naming a bridge after the Governor-general was probably the best and only way to relay the colony’s plight to him.⁶⁴

A TECHNOLOGICAL CONTEXT IN THE DEVELOPMENT OF SINGAPORE

The process of importing and naming the five bridges embodied the complex tripartite relationship of powers governing the colony. This chapter had showed how social, political and economic factors played a part in the transfer of technology from Britain to Singapore. At the global scale, infrastructure development in Singapore was largely determined by policymakers within and beyond Singapore. The next chapter will examine the urban growth of the settlement around Singapore River and trace how the appearance of the five historic bridges played a pivotal role in the transformation of the riverine landscape, communities and commercial activities around the bridges.

⁶⁰ Yeoh (2003) *Contesting Space in Colonial Singapore*, Singapore University Press, Singapore, pp221-2

⁶¹ Anderson Bridge, *The Straits Times*, 1 July 1908, p7

⁶² Wan (2009) *Heritage Places of Singapore*, Marshall Cavendish Editions, Singapore, p15

⁶³ Wan (2009) *Heritage Places of Singapore*, Marshall Cavendish Editions, Singapore, pp13-4

⁶⁴ Municipal Council, *The Straits Times*, 26 July 1862, p1

CHAPTER 3: MACRO

THE CHARACTERISTICS OF A COLONIAL PORT CITY

Right from the founding of the settlement, Sir Stamford Raffles regarded Singapore only as a commercial centre. He wrote, *“Our object is not territory but trade; a great commercial emporium and a fulcrum where we may extend our influence politically as circumstances may hereafter require”*.⁶⁵ In one sentence, Raffles had encapsulated the opinion British colonisers held towards port cities. For them, the ports of the Far East were not intended for permanent white settlement. Instead, they were meant to serve ships plying the lucrative Europe-India-China route. As the last chapter had shown, Singapore was established for the same reasons. A sequence of global events, such as the opening of the Suez Canal and the invention of the steamship complemented the inherent advantages Singapore had: a central location within Southeast Asia, a thriving entrepot trade and the naturally sheltered harbour of Singapore River. All these factors helped promoted Singapore as the *“Emporium of the East”*.⁶⁶

The character of the port city was unlike the *Grand Modell* of town planning which Home applied to British colonies.⁶⁷ The main ideology driving the planning of the Singapore colony was not a desire to *“express political authority through physical form”*⁶⁸, instead it was primarily pragmatic in character. British businessmen and Asian migrant workers were united in a common belief to *“work in the new settlement, make their fortunes quickly and return home”*⁶⁹ The town planning of Singapore was thus set up with the objectives of maximising trade and minimising the possible conflicts among different races and occupation groups.

⁶⁵ Turnbull (1977) A History of Singapore, 1819-1975, Oxford University Press, Kuala Lumpur, p21

⁶⁶ Turnbull (1977) A History of Singapore, 1819-1975, Oxford University Press, Kuala Lumpur, p3

⁶⁷ Home (1997) Of Planting and Planning, E&FN Spon, London, p3

⁶⁸ *ibid*

⁶⁹ Turnbull (1977) A History of Singapore, 1819-1975, Oxford University Press, Kuala Lumpur, p78

These fundamental principles guided the layout of the new settlement. Raffles personally appointed a committee to plan the “*economical and proper allotment of the ground intended to form the site of the principal town*”.⁷⁰ The decisions made by the committee had a lasting effect on the urban landscape as vestiges of the land allotment system could still be distinguished today.

This chapter will first provide a chronological overview of the urban development around Singapore River in a span of 150 years. It will focus on three important periods: the founding period, the Crown colony period and the post-independence period. Secondly, the chapter will discuss how these five historical bridges could be used to understand the urban morphology of the colonial port city in the 19th and 20th century.

FORMATION OF THE PORT CITY 1822-1830

Trade was the main reason behind the establishment of Singapore as a British settlement. The island occupied a strategic location along the Europe-India-China trading route for European and Asian vessels. As the significance of the port increased in the early 1820s, Singapore River became a bustling entrepot where goods from the region and beyond were traded. Early accounts of the river described the large number of boats in the harbour and the amount of commercial activity carried out.⁷¹ The river possessed qualities required of a trading port—a safe harbour for ships to moor, sufficient land to accommodate visiting traders and a ready availability of fresh water.

Most infrastructure development in Singapore occurred after 1822. The uncertain status over the sovereignty of the port stalled development. The confirmation of Singapore’s status as a British settlement in the 1824 Anglo-Dutch treaty ushered in a period of rapid development.⁷² During Raffles’ second visit to Singapore in June 1819, he defined the boundaries of the British settlement

⁷⁰ Yeoh (1996) *Contesting Space in Colonial Singapore*, Singapore University Press, Singapore, p31

⁷¹ Dobbs (2003) *The Singapore River A Social History 1819-2002*, Singapore University Press, Singapore, p5

⁷² Turnbull (1977) *A History of Singapore, 1819-1975*, Oxford University Press, Kuala Lumpur, p34

with local Malay rulers and finalised it as “the stretch from Tanjong Malang on the west to Tanjong Katong on the east and inland as far as the range of a cannon shot.”⁷³ With this boundary, Raffles was able to make a rough plan with different zones for residential and commercial activities. It was finally put to action on his final visit in 1822.

Raffles set up a Land Allotment Committee during his last visit to implement his plan for Singapore. The committee was intentionally varied to provide a balanced viewpoint. It consisted of Captain CE Davies of the Bengal Native Infantry, George Bonham of the Bencoolen Civil Service and A L Johnston, owner of an early mercantile firm in Singapore.⁷⁴ The plan was finalised and implemented in 1823 with some revisions. Most significantly, the river had replaced the seafront as the mooring site for vessels. Although the seafront had a larger area, the shallow waters and the tidal swell during monsoon rains increased the risk of damage to goods and vessels. Conversely, the river provided a naturally sheltered harbour which was suitable for moving goods in all weather conditions, but the limited river frontage and the narrow width of the river hindered future developments.

Apart from the limitations of the river for development, the topology of the area was not favourable for trade as well. The south bank of the river was “nine feet lower than the opposite bank, creating at high tide, a vast inland lake and at low tide a marshy bog.”⁷⁵ An embankment had to be built to contain the river. According to an account by Malay scholar Munshi Abdullah, a small hill at the location of Raffles Place today, was levelled by shovels. Chinese, Indian and Malay labourers were rounded up and paid one rupee per day to pile the riverbank with earth and stone.⁷⁶ The reclamation work was arduous but necessary. It was the first of many instances whereby Singapore River and its surroundings was altered for the sake of commercial and urban development.

⁷³ Turnbull (1977) A History of Singapore, 1819-1975, Oxford University Press, Kuala Lumpur, p12

⁷⁴ Yeoh (1996) Contesting Space in Colonial Singapore, Singapore University Press, Singapore, p28

⁷⁵ Dobbs (2003) The Singapore River A Social History 1819-2002, Singapore University Press, Singapore, p9

⁷⁶ Hon (1987) Tidal Fortune, A Story of Change, Landmark Books, Singapore, p12

Four districts were created in Raffles' Town Plan (**Fig 7**):

The first district on the North Bank was reserved for the Government. The plot stretched from Government Hill (now Fort Canning) to the mouth of the river. It offered a strategic military point overlooking the settlement, as well as river access to the commercial area on the South Bank.

The second district on the South Bank was allocated to businessmen. The area was highly coveted by merchants due to its dual frontage along the river and the sea. With time, the area developed into a commercial zone where merchants gather. The reclaimed area on the south bank was given prominence in recognition of its vital economic role. Access to this valuable crescent-shaped riverfront was granted on the basis of occupation and ethnicity.

The third district occupied the river frontage further upstream from the European traders; its boundary extended south along the beach of Telok Ayer. The plot allocated to the Chinese was the largest amongst the different groups. Raffles had anticipated correctly that the settlement would attract a substantial number of migrant workers from different parts of China. In order to prevent conflicts amongst the Chinese, the district was sub-divided into smaller areas specific to speakers of different dialects. The original ethnicity division is still reflected in the street names of the area today.

The fourth district was allocated to the *Chuliahs*, a particular group of Indians from the Coromandel Coast who specialised in the repair of timber-hulled boats. The *Kampong Chuliah* area allocated near the trading area highlighted the need for essential services, such as boat repair and metal smiting, to be located at close proximity.

The allocation of the different plots was shown in the town plan drawn up by Lieutenant P Jackson (**Fig 8**). Apart from the plots, the plan also marked the first bridge spanning Singapore River. Presentment Bridge, designed by Jackson, was constructed as a foot bridge in 1823 to facilitate the pedestrian traffic between the government district and the Chinese Commerce district.⁷⁷

⁷⁷ Powell (2004) *Beyond Description Singapore Space Historicity*, Routledge, London, p125

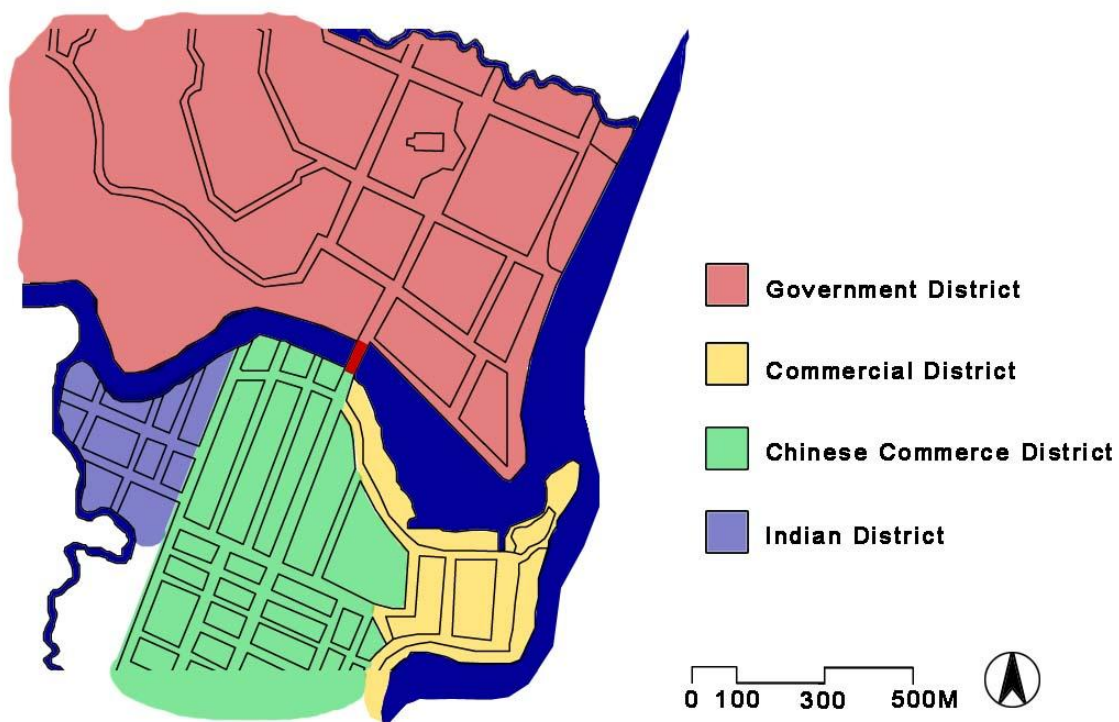


Fig 7: Occupation and Racial Districts in Raffles Town Plan (1823)



*Figure 8: Plan of the Town of Singapore (1827)
(Based on Raffles Town Plan of 1823)*

Presentment Bridge was the only bridge spanning the river for twenty years until the first Coleman Bridge was constructed in 1840. The absence of bridges reflected the settlement's predominant river transport system in its first two decades of establishment. Goods and people were transported by boat and there was hardly any need to carry goods across the timber bridge during this period.

THE RAPID DEVELOPMENT OF THE NEW CROWN COLONY 1852-1929

The initial period of development in the fledgling Singapore town was cut short by two global events. Firstly, the East India Company ran into a financial crisis in 1830. Secondly, the company lost its trade monopoly in China in 1833.⁷⁸ The first event drastically reduced the East India Company's financial support for Singapore. Together with the Straits Settlements, Singapore was reduced to the status of a Residency under Bengal. Just barely three years later, the second event further reduced the need for the colony. With less cargo ships plying the Europe-China route, the company saw Singapore as a *"useless burden"*.⁷⁹ A *"negative policy in the Straits"* was pursued during Indian rule to avoid financial deficit for the company.⁸⁰ Financial support for Singapore was severely curtailed and it affected the infrastructure development of the town from 1830 to 1852.

Much of the town's improvement during this period was credited to the efforts of the colony's first Superintendent of Public Works (later renamed as Colonial Engineer), G D Coleman. Despite a chronic shortage of funds, Coleman managed to carry out road building and land reclamation with the help of Indian convicts from Calcutta.⁸¹ The convict workforce proved to be industrious and reliable. During Coleman's appointment from 1833 to 1844, he had drained several

⁷⁸ Turnbull (1977) A History of Singapore, 1819-1975, Oxford University Press, Kuala Lumpur, p34

⁷⁹ Turnbull (1977) A History of Singapore, 1819-1975, Oxford University Press, Kuala Lumpur, p35

⁸⁰ ibid

⁸¹ For an understanding of the Indian Convict Workforce, refer to McNair(1899) Prisoners Their Own Wardens, Republished by Dado Press (2012), New York

marshes, constructed numerous roads and designed many classical civic and ecclesiastical buildings still standing today. His biggest achievement however, was reclaiming the sea front from the government district to Kampong Gelam, the Sultan's village.⁸² By doing so, the seafront allowed small crafts to moor and trade. It was the first of many subsequent attempts to expand the trading area beyond Singapore River. Instead of siphoning away trade from the river, opening more harbours increased trading volume and helped accelerate urban development around Singapore River when economic conditions were favourable.

Steamships started appearing in Singapore in the 1840s.⁸³ Within thirty years, the steamship would overtake the sail clipper to become the dominant cargo ship. As the deep iron hulls of steamships were not suitable for the relatively shallow waters of the Singapore River, a new harbour was built. Keppel Harbour was established in 1852 (**Fig 9**). It offered deep water berthing, servicing facilities and goods storage for large vessels.⁸⁴ The new harbour complemented the activities at Singapore River and allowed different services to be offered. Keppel Harbour attracted larger ocean vessels while Singapore River served smaller vessels from Thailand, Indonesia and Malaya. The demand in Europe for Asian products encouraged more regional vessels to trade at Singapore River. According to the Marine Department's reports, the number of regional vessels quadrupled from 4,657 in 1880 to 17,167 in 1920. In the same period, the gross tonnage of goods also increased sevenfold to more than one million tons annually.⁸⁵

The lucrative entrepot trade in Singapore was made possible with an efficient overland transport of goods from Singapore River to Keppel Harbour and vice versa. The construction of the road system provided the impetus for a progressive sprawling of the city from Singapore River to Keppel Harbour. Increased public budget and profits generated from the trade industry during the Crown Colony period allowed necessary public works to be commissioned. The sandy beach of Telok

⁸² Hon (1987) *Tidal Fortune, A Story of Change*, Landmark Books, Singapore, p15

⁸³ Turnbull (1977) *A History of Singapore, 1819-1975*, Oxford University Press, Kuala Lumpur, p40

⁸⁴ Dobbs (2003) *The Singapore River A Social History 1819-2002*, Singapore University Press, Singapore, p11

⁸⁵ *ibid*

Ayer between Singapore River and Keppel Harbour was reclaimed. Following the same method of reclaiming the South Bank of Singapore River, small hills between the town and Keppel Harbour were levelled and the earth was used to construct a seawall along Telok Ayer.

Motorised vehicles soon replaced bullock carts in transporting goods between Singapore River and the Keppel Harbour. Surveys conducted by the Municipality between 1917 and 1930 found the number of Lorries increasing from 92 in 1917 to 1564 in 1930. Concurrently, the number of bullock carts decreased from 358 to 25.⁸⁶ A new form of road building was also introduced during this period to replace the Macadam roads constructed during Indian rule. Macadam roads were *“made with a layer of soft Laterite stone on a hardcore of stone”*. They wore off easily and were dusty during dry weather.⁸⁷ New roads were replaced with granite to overcome these problems. Large stone blocks were laid manually on the roads and the spaces in between were compacted with granite chips. A layer of asphalt was then applied onto the stone surface to produce roads which were able to withstand the loading of motorised vehicles **(Fig 10)**.

Transportation links between Keppel Harbour and the town were further improved when tramlines were laid in the 1890s. The Singapore-Kranji Railway also built an extension from the town to Keppel Harbour in 1907.⁸⁸ When Telok Ayer Basin officially opened in 1932, the city *“stretched almost continuously from Singapore River in a southern direction to Keppel Harbour”*.⁸⁹ **(Fig 11)**

Bridges and roads were essential in connecting business communities on the two banks of Singapore River. Small roads gradually expanded to form thoroughfares across the two banks of Singapore River. South Bridge Road and New Bridge Road are parallel thoroughfares which connected business communities on the two banks of Singapore River to Keppel Harbour. Presentment Bridge and Coleman Bridge gave South Bridge Road and New Bridge Road their

⁸⁶ Rimmer (1986) *Rikisha to Rapid Transit, Urban Public Transport Systems and Policy in Southeast Asia*, Pergamon Press, Sydney, Table 4.3

⁸⁷ Cheong (1992) *Framework and Foundation, A History of PWD*, Times Edition, Singapore, p32

⁸⁸ Dobbs (2003) *The Singapore River A Social History 1819-2002*, Singapore University Press, Singapore, p12

⁸⁹ Ibid

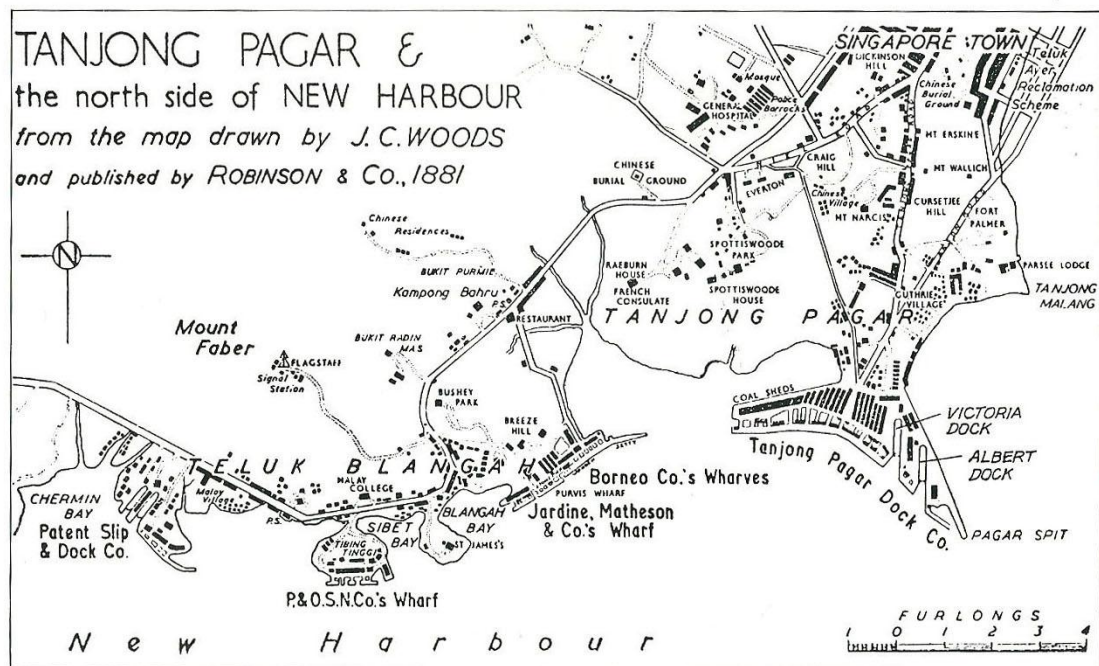


Fig 9: Keppel (New) Harbour, 1881

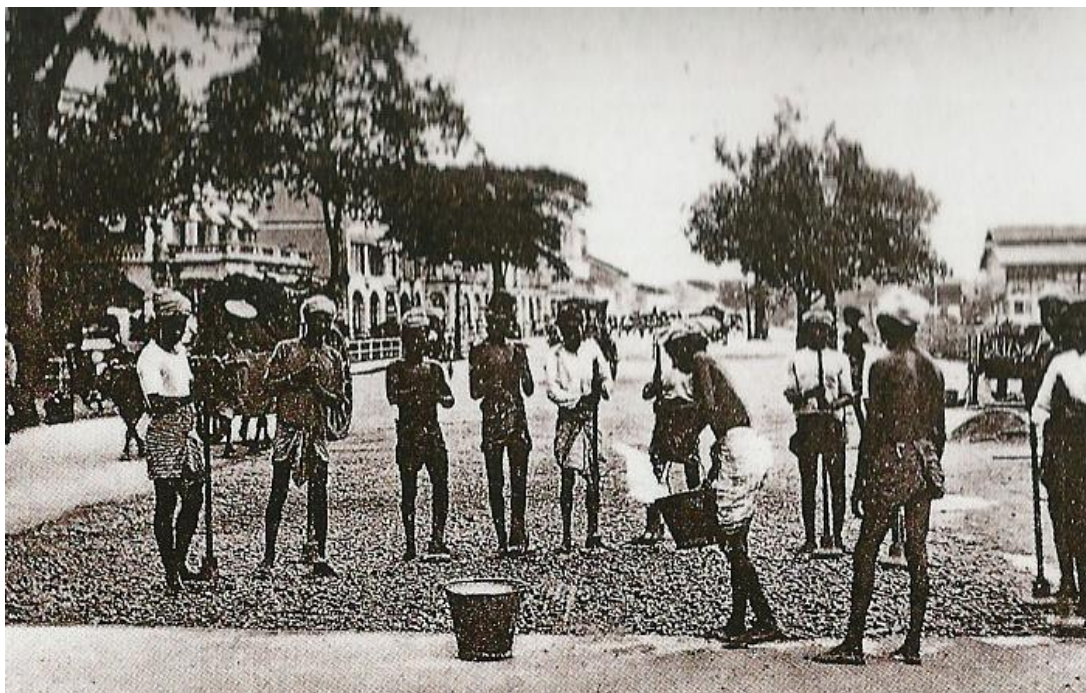


Fig 10: Road Paving in Singapore, 1880s



Figure 11: 1920s Shoreline from the mouth of Singapore River (right) to Telok Ayer Basin (left) and Keppel Harbour (far left)

namesakes respectively. The thoroughfares played such an important role in the economic and social development of the city that an urban researcher had named them the “axis of Singapore”.⁹⁰

Commercial firms, retail stores and shipping houses congregated along the two roads on the South Bank whereas European firms, hotels and civic buildings flanked the roads on the North Bank. This gave rise to the colloquial names for the two areas—*Twa Poh* (Big District), referring to the more densely populated town on the South Bank, and *Seoh Poh* (Small District), referring to the European district on the North Bank.⁹¹ The bridges not only served as the “division” between the two districts, their significance as part of the thoroughfares could also be seen from their frequency of reconstruction in the 19th and 20th century. **(Fig 12)**

Presentment Bridge was constructed in 1823 and subsequently renamed Elgin Bridge. It was reconstructed in 1840, 1863 and 1929; Coleman Bridge was constructed in 1840 and was replaced in 1865, 1886 and 1991.⁹² The frequent reconstruction of the bridges during the Crown Colony period and the successive changes of construction materials from timber to iron and to reinforced concrete highlighted the increasing load and traffic the bridges had to handle as entrepot trade in Singapore prospered.

FORGING A NEW NATIONAL IDENTITY WITH THE SINGAPORE RIVER 1977-1991

Public works around Singapore River stopped in the 1930s as the global economy was hit by the dual blows of World War I and the Great Depression. The slump hit Singapore particularly hard, since it was dependent upon the export of Malayan tin and rubber to the Western market.⁹³ The economic rebound during the interwar years and a demand for rubber in producing motorised

⁹⁰ Powell (2004) *The Axis of Singapore in Beyond Description: Singapore Space Historicity*, Routledge, London, pp125-6

⁹¹ Powell (2004) *The Axis of Singapore in Beyond Description*, Routledge, London, p129

⁹² Tyers (1976) *Singapore Then and Now*, University Education Press, Singapore, p20

⁹³ Turnbull (1977) *A History of Singapore, 1819-1975*, Oxford University Press, Kuala Lumpur, p131

vehicle parts boosted the export of tin and rubber in the 1920s. However this led to overproduction and the prices of these commodities plummeted after 1929.⁹⁴

As a result, Singapore's revenues dwindled but public expenditure remained high. The economic rebound in the inter-war years had encouraged the Colonial Government to start several ambitious public works projects, including the construction of the first municipal power station (1927), the General Post Office (1928) and the Municipal Building (1929).⁹⁵ After 1930, the government slashed salaries, reduced spending and started repatriating Chinese and Indian migrant workers to cut its deficits. During the slump, the government had neither the financial means nor the manpower to commission public works projects, including the construction of bridges.⁹⁶

The Great Depression was followed by the tumultuous periods of World War II, violent struggles for independence and racial riots during the union of Singapore and Malaysia between 1963 and 1965. The independence of Singapore marked a new phase of development for the country. The long-neglected Singapore River underwent a \$23 million project to transform it into a *"major artery of trade again"*.⁹⁷ Maintenance works were carried out on the historic bridges but no restoration works were initiated as the Public Works Department focused on building new road bridges. Kim Seng Bridge (1954) and Merdeka Bridge (1956) were the first bridges constructed with pre-stressed reinforced concrete, then considered an innovative construction system in the 1950s.⁹⁸

By the 1970s, Singapore was moving away from the river entrepot trade which had contributed to its colonial success. Singapore River's image of "dirty, smelly overcrowded waters and squatter-lined banks" did not fit well with the aspirations of the new metropolis.⁹⁹ In 1977, the Prime Minister, Mr Lee Kuan Yew declared his aim to clean up Singapore River.¹⁰⁰ This signalled the

⁹⁴ Turnbull (1977) *A History of Singapore, 1819-1975*, Oxford University Press, Kuala Lumpur, p138

⁹⁵ Wan (2009) *Heritage Places of Singapore*, Marshall Cavendish Editions, Singapore, p68, p88 & p168

⁹⁶ Cheong (1992) *Framework and Foundation, A History of PWD*, Times Edition, Singapore, p33

⁹⁷ Pillal, Soil Test for \$23 mil River Scheme, *The Singapore Free Press*, 22 Nov 1960, p1

⁹⁸ Cheong (1992) *Framework and Foundation, A History of PWD*, Times Edition, Singapore, p50

⁹⁹ Dobbs (2003) *The Singapore River A Social History 1819-2002*, Singapore University Press, Singapore, p15

¹⁰⁰ Hon (1987) *Tidal Fortune, A Story of Change*, Landmark Books, Singapore, p41

start of the decade-long *River Clean-Up Project*. Trading firms and warehouses along the river were evicted while lighter boats were relocated to Pasir Panjang Wharves in the west of Singapore. Debris from the river bed was dredged up and the river banks were repaved with new granite blocks. By 1987, pollution levels in the river had dropped so drastically that it was “*capable of supporting most aquatic life suitable for such waters.*”¹⁰¹

In recognition of the tourism potential of the new Singapore River, a master plan was unveiled by National Development Minister Teh Cheang Wan in 1986 to *preserve “as much of its traditional atmosphere as possible”*¹⁰² The five historical bridges were seen as “*a means to tell a nation’s history*”. They were thus earmarked for an ambitious rehabilitation project which restored the bridges to their former glory.¹⁰³ From 1985 to 1991, millions were spent in restoring the five bridges and the reconstruction of Coleman Bridge.¹⁰⁴ The structure of Anderson Bridge and Elgin Bridge were restored and reinforced to cope with road traffic while Cavenagh Bridge, Read Bridge and Ord Bridge were converted to pedestrian use.¹⁰⁵

By 1987, the clean-up operation was widely acclaimed as a success. The scenery along the Singapore River was even compared to those of the Seine in Paris and the Tiber in Rome.¹⁰⁶ However in the absence of the bustling river trade and the lighters, the restored historic bridges no longer relate to its original urban context. **(Fig 13)**

¹⁰¹ Seetoh, Dramatic Drop in River Pollution, The Straits Times, 4 Sep 1987, p1

¹⁰² Bridges to the Past along the River, The Straits Time, 5 Oct 1986, p1

¹⁰³ Cheong (1992) Framework and Foundation, A History of PWD, Times Edition, Singapore, p50

¹⁰⁴ Cavenagh Bridge reopens to public, The Straits Times, 6 May 1987, p15

¹⁰⁵ Bridge Closure, The Straits Times, 20 Feb 1988, p13

¹⁰⁶ Hon (1987) Tidal Fortune, A Story of Change, Landmark Books, Singapore, p96

Seoh Poh



Twa Poh

Fig 12: Elgin Bridge (Arch Bridge in the middle) and Coleman Bridge delineating Seoh Poh (Small District) on the North Bank (left) and Twa Poh (Big District) on the South Bank.

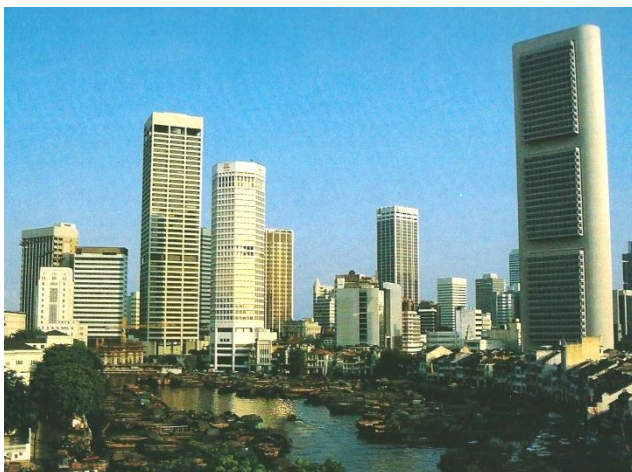


Figure 13: A comparison between the scenery of Singapore River in 1983 before the lighters were evicted and a similar scenery taken in 2012.

BRIDGES IN THE URBAN MORPHOLOGY OF THE PORT CITY

Apart from understanding the historic bridges from an economic and historic viewpoint, it is also important to see the five bridges as key components in the reading of the historic fabric. The previous section had highlighted how the transformation of Singapore River had removed all traces of its river entrepot except for the five bridges. As they have occupied their original positions since the 19th century, the bridges are perhaps the few landmarks that had remained in the urban morphology of the port city during the 19th and 20th century. **(Fig 14)**

Even though most of the original road network and buildings around Singapore River have been altered or demolished, the positions of the historical bridges have not changed. They become references to the growth of the city. Elgin Bridge was not only part of an important thoroughfare; it also marked the division between the commercial activities at the river's mouth and the mixed residential area and industrial activities upstream.¹⁰⁷ Large vessels were not able to enter the shallow waters of Singapore River. Hence small boats called lighters were used to transfer goods from vessels moored at the mouth of Singapore River to warehouses upstream.¹⁰⁸ Over time, a *Two Harbour* port typology was developed.¹⁰⁹

In order to trade with vessels moored at the mouth of the river, trading houses and lighters congregated around the river mouth of the commercial district. This was known as the *Outer Harbour*. By the 1860s, established European firms had trading houses with jetties and lighter fleets along the river walls. This caused the river mouth to be congested and it hindered movement between the government and the commercial district on opposite banks. **(Fig 15)** It was necessary for the construction of Cavenagh Bridge in 1868 to provide quick access between the two districts.¹¹⁰

¹⁰⁷ Cameron (1865) *Our Tropical Possessions in Malayan India*, Smith, Elder and Co, London, p59

¹⁰⁸ Dobbs (2003) *The Singapore River A Social History 1819-2002*, Singapore University Press, Singapore, p27

¹⁰⁹ *ibid*

¹¹⁰ Cavenagh Bridge, *The Straits Times*, 23 April 1870, p1

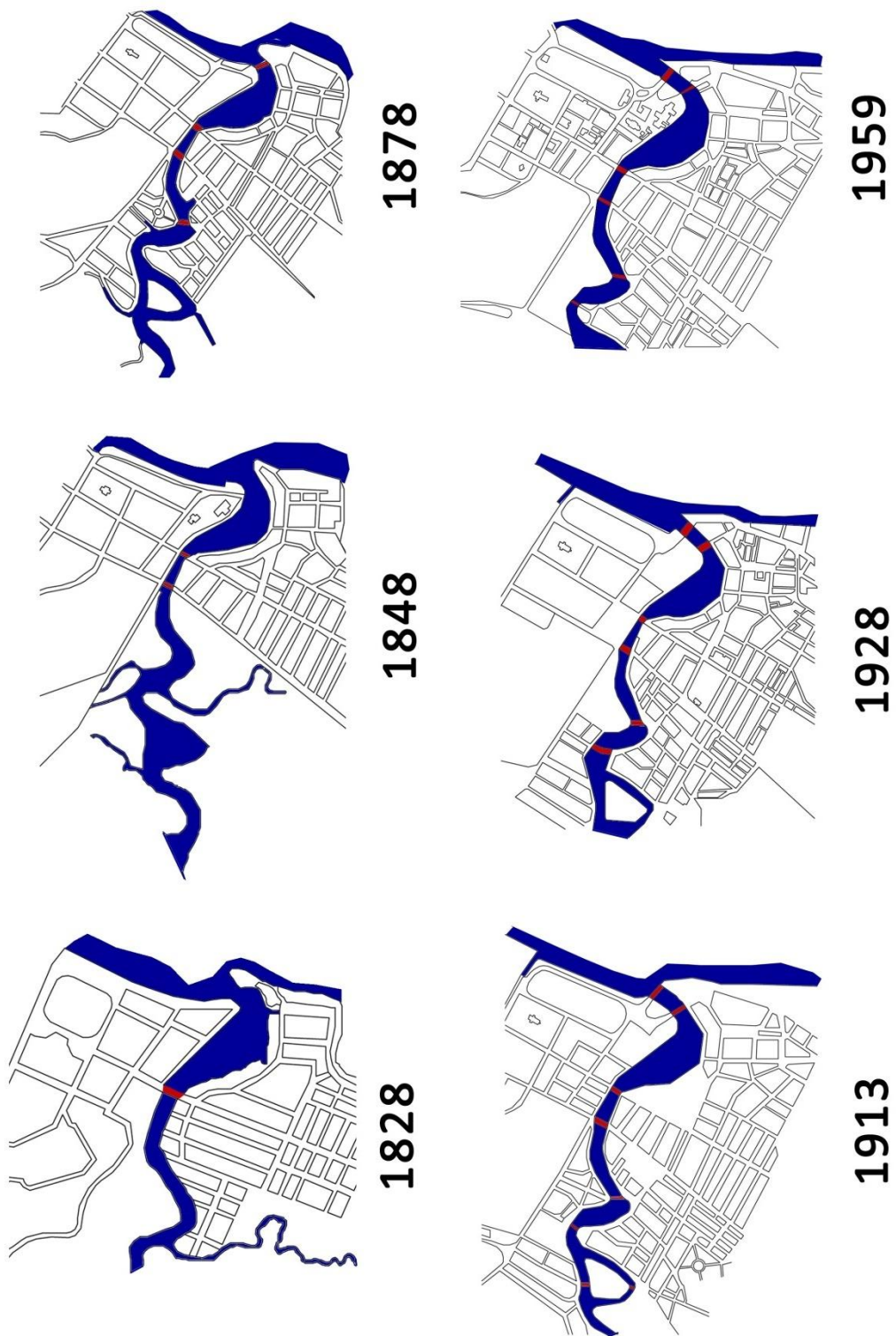


Fig 14: Changes in Singapore River's urban morphology and the construction of bridges between 1819 and 1960

Piers and wharves sprung up along Telok Ayer from 1890s to 1920s as the sandy beach was reclaimed.¹¹¹ The number of motorised vehicles around Singapore River increased drastically during this period as trade between European and regional vessels increased. Anderson Bridge was built in 1910 to alleviate the heavy traffic condition on Cavenagh Bridge and to provide quick access from Kampong Gelam to Keppel Harbour along the coastal road.¹¹² Vestiges of the urban development can still be identified today with key landmarks such as the Esplanade, Clifford Pier and Raffles Place.

Inner Harbour referred to the stretch of Singapore River from Elgin Bridge to Ord Bridge. It is characterised by the large warehouses lining the North Bank, and the densely packed residential shophouses on the South Bank. **(Fig 16)** This area was called Kampong Malacca, an allusion to where most of the regional goods originated from. The warehouses belonged to businessmen running trading houses in the *Outer Harbour*. These include prominent businessmen such as Boutstead, Balestier, Guthrie and Tan Kim Seng.¹¹³ The area was suitable for storing goods as the upper end of the river was rarely affected by severe storms and flooding.¹¹⁴ From the outer harbour, lighters were used to transfer goods from the sea vessels to the warehouses. When a subscription was raised in 1862 to construct a new bridge connecting Kampong Malacca to the Chinese district, it was unanimously named Merchant Bridge to commemorate the important role of the businessmen's warehouses in the area.¹¹⁵ The bridge was constructed in 1863 and was replaced by the first Read Bridge in 1887. Similar to other bridges built on the river, Read Bridge and Ord Bridge were constructed to transport goods from the warehouses to Keppel Harbour.

However the area surrounding Read and Ord Bridge had been altered drastically in the course of late 20th century regeneration programmes. The shophouses and most warehouses were demolished. A small cluster of the original warehouses on Read Street had been retained, restored

¹¹¹ Dobbs (2003) *The Singapore River A Social History 1819-2002*, Singapore University Press, Singapore, p12

¹¹² Anderson Bridge Opening, *The Straits Times*, 12 March 1910, p7

¹¹³ Berry (1982) *Singapore River: A Living Legacy*, Eastern Universities Press, Singapore, p82

¹¹⁴ Dobbs (2003) *The Singapore River A Social History 1819-2002*, Singapore University Press, Singapore, p27

¹¹⁵ Untitled, *The Straits Times*, 21 June 1862, p1



Fig 15: The Outer Harbour congested with lighter boats and rows of trading houses in the background



Fig 16: The large warehouses in the Inner Harbour

and revamped as Clarke Quay, a popular nightlife area. Yet without the original urban setting and functions, the two pedestrian bridges look incongruent in the new surroundings. **(Fig 17)**

UNDERSTANDING HISTORIC BRIDGES FROM A MACRO TO MICRO LEVEL

By understanding the three significant phases of the port city's history, we had observed how the role of the five historic bridges had transformed from having a functional purpose to becoming historical symbols today. Such changes reflect the evolving development needs of the city and how different agencies determine the functions and symbolism the bridges portray. In similar ways, the following chapter on micro aspects will explore how different factors affected the design of the bridges. The next chapter will also discuss the technology and aesthetic aspects of the bridges and show how structural design, material and construction methods of the bridges were intertwined with global and macro factors.

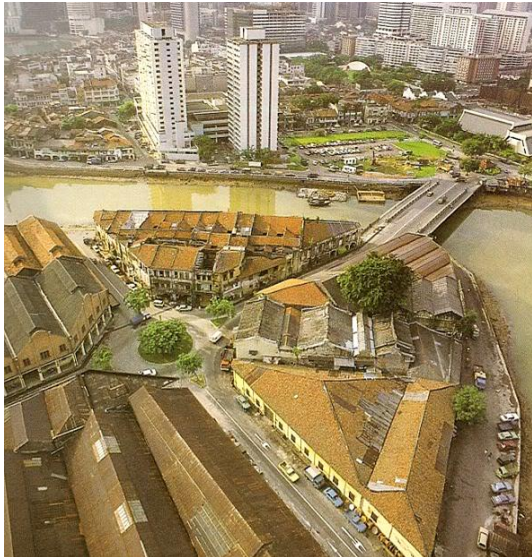


Fig 17: Comparison of former Kampong Malacca in 1983 (left) and the “revamped” Clarke Quay in 2006

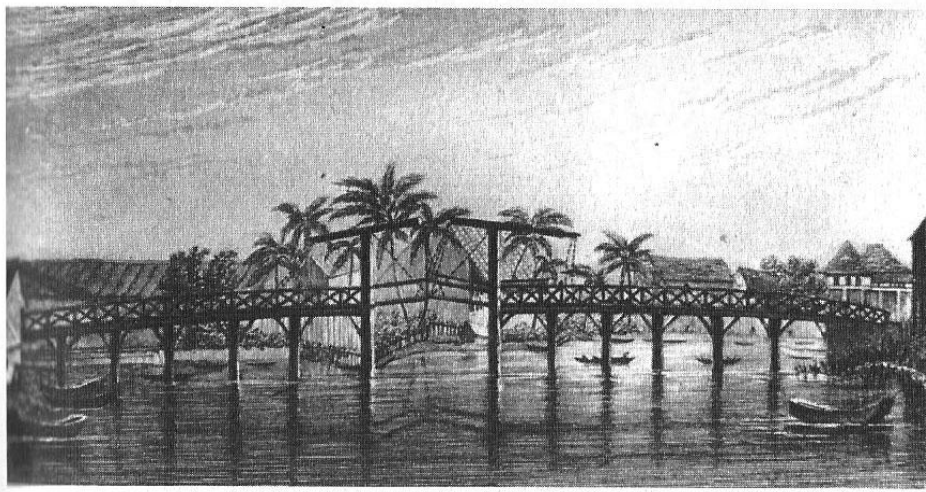


Fig 18: Painting of Singapore River and Presentment Bridge by Francois Edmond Paris in 1830. The painting below shows a close-up of the drawbridge during the same period, painted by John A Heraud in 1837.

CHAPTER 4: MICRO

THE FUNCTIONS AND ROLE OF BRIDGES IN COLONIAL SINGAPORE

The previous chapters have shown the social-economic significance of the five historic bridges at the global and macro scales. This chapter will discuss the construction and structural design of the bridges and referencing them to global influences and urban development needs. There will be two main points of discussion.

Firstly, this chapter will demonstrate that the structural design of the five bridges was influenced by bridges constructed in Britain and Australia during the 19th and 20th century. It will show how the five bridges were characteristic of designs during that period. The progressive shift in the use of wrought iron to steel and to reinforced concrete to build the five bridges will be cross-referred to notable British bridges of the same material and time period. It will hence pinpoint a relationship between the rate of technology transfer from Britain to Singapore and the pace of Britain's advances in bridge construction in the 19th and 20th century.¹¹⁶

Secondly, the chapter will discuss how the construction of the bridges affected river traffic and entrepot trade. It will also focus on how the designs of the bridges were affected by the shipping sizes of components and the ability of local workers to reassemble the components. Lastly, the section will focus on the practical aspects of bridge design. These include understanding the height clearance under the bridge, the ease of assembly and the disruption of river traffic during construction.

¹¹⁶ Norrie (1956) *Bridging the Years, A Short History of British Civil Engineering*, Edward Arnold Ltd, London, p134

EARLY BRIDGE CONSTRUCTION IN COLONIAL SINGAPORE

The earliest bridge over Singapore River, Presentment Bridge, was constructed using local timber. Although no records of its construction have been found, the bridge was drawn by a French naval officer, Francois Edmond Paris during a voyage in 1830.¹¹⁷ **(Fig 18)** Unlike the single or double spans of the historic iron bridges, Presentment Bridge was built on 12 closely-spaced timber piles driven into the river. It was designed by Lieutenant Philip Jackson, an engineering officer from the Bengal Regiment and was constructed by *Sepoy* soldiers¹¹⁸. The bridge represented one of the earliest examples of technical knowledge transfer from Britain to Singapore. More importantly, the structure showed how a western design could be realised using local materials and unskilled labour.

Even though British-made iron bridges were exported to India from 1840 onwards,¹¹⁹ such bridges only appeared in Singapore after 1862. As Singapore did not receive monetary support during Indian Rule, the colonial government could not afford to import new technology from Britain. Hence, the colony depended on the Indian convict workforce and available local materials for constructing bridges. Before 1862, wooden bridges were built across Singapore River and other smaller tributaries. Within forty years of the settlement's establishment, there were more than forty wooden bridges in Singapore. This was set out in the 1854 Municipal Report, which also listed the working conditions of these bridges.¹²⁰

On Singapore River, prominent wooden bridges included Presentment Bridge (1822), the first Coleman Bridge (1840), Thomson's Bridge (1844) and the second Coleman Bridge (1865). A Municipal Engineer's report on the construction of the 2nd Coleman Bridge provided valuable

¹¹⁷ Reproduced in Wong (2010) *Singapore through 19th Century Paintings*, Didier Millet, Singapore, p30

¹¹⁸ Pearson (1955), *People of early Singapore*, University of London Press, London, pp109-114

¹¹⁹ Ponnuswamy (2008) *Bridge Engineering*, Tata McGraw-Hill, New Delhi, p xiv

¹²⁰ Half yearly reports on the state of Municipal Works, The Singapore Free Press, 18 July 1854, p5

information on the type of timber used, the work involved and how the cost of erecting the bridge was reduced by using Indian convict labour:

“...the timbers of the Bridge were of the largest scantling; the piles for the piers vary from 14 to 12 inches square. The stretcher beams were 12 inches square and all the other timbers in proportion. All these and the flooring were of Tampenies Wood.

The total cost of the Bridge reckoning the employment of Free Labour throughout would have amounted to \$15,005.64. Convict labour made available for raising the approaches to the Bridge, altering the stone landing stairs and in building the two abutments, effected a saving of \$2188. A further saving of \$2000 was effected when the Convict Department undertook the unskilled labour, such as dragging and placing heavy timbers, driving piles, etc...the total savings amounted to \$5,647.15, leaving a balance of \$9,358.49.”¹²¹

During the Crown Colony period, wooden bridges were phased out. Many were demolished as they could not support the weight of motorised vehicles. Iron and steel became preferred materials for bridge construction as their prices dropped.¹²²

IRON AND STEEL BRIDGES IN THE 19TH AND 20TH CENTURIES

The use of iron for structural work became popular in the late 19th century due to its high strength and ability to make long spans. The manufacturing cost of the material decreased as it became mass produced.¹²³ The materials used for the structures of the five bridges, ranging from wrought iron and cast iron to steel and to reinforced concrete mirrored global trends in bridge construction during the 19th and 20th century. The study of material and structural systems used in

¹²¹ Superintendent of Public Works Report to Resident Councilior, 25 July 1865, published in The Straits Times, 12 Aug 1856, p5

¹²² Headrick (1988) The Tentacles of Progress, Oxford University Press, New York, p277-289

¹²³ Beckman and Bowles (2004) Structural Aspects of Building Conservation, Elsevier, London, p198

the five historic bridges over Singapore River thus provide an understanding to why the material was used, the type of load it was designed to carry and its global influences.

Wrought iron was popular for constructing bridges in the 19th century. Examples of wrought iron chain bridges constructed by British engineers include Telford's Menai Straits Suspension Bridge (1826) and Clarke's Szechenyi Chain Bridge in Budapest (1849). Wrought iron was first introduced to Singapore during the construction of Elgin Bridge in 1862. **(Fig 19)** Subsequently, the material was used to construct Cavenagh Bridge (1868), the third Coleman Bridge (1886), Ord Bridge (1886) and the first Read Bridge (1889).¹²⁴

Cavenagh Bridge is the oldest of the five extant historic bridges. It is also the first bridge in Singapore designed by a consulting engineer based in London. The engineer, Rowland Mason Ordish had based the design of the bridge on his earlier design for Štefánik Bridge over the Vltava in Prague (1868).¹²⁵ The "Ordish" rigid suspension system which he developed and used for the two bridges was also adopted for his design of Albert Bridge over River Thames in London (1873).¹²⁶ **(Fig 20)**

Cavenagh Bridge is 200 feet (60m) long and has a 25 feet (8m) wide roadway. **(Fig 21)** A newspaper report described its structural system: *"the bridge is suspended by a system of straight chains and an auxiliary catenary passing over the saddle in the towers to the moorings in the abutments. These support the four sets of main links, so that they are always kept absolutely straight and rendered rigid"*.¹²⁷ By inclining the chains instead of hanging them, *"the strain is accumulated towards the girders nearest the piers like an ordinary cantilever"*.¹²⁸ **(Fig 22)** It provided better stability, greater structural strength and load bearing compared to a standard suspension bridge.

¹²⁴ Cheong (1992) Framework and Foundation, A History of PWD, Times Edition, Singapore, pp50-59

¹²⁵ Moss and Hume(2001), Bridge Building Achievements of P&W MacLellan, in Transactions of Newcomen Society, Vol 72, p183

¹²⁶ Ibid, quoted from Engineer Magazine, 17 Sep 1886, pp232-3

¹²⁷ Cavenagh Bridge, The Straits Times, 23 April 1870, p1

¹²⁸ ibid

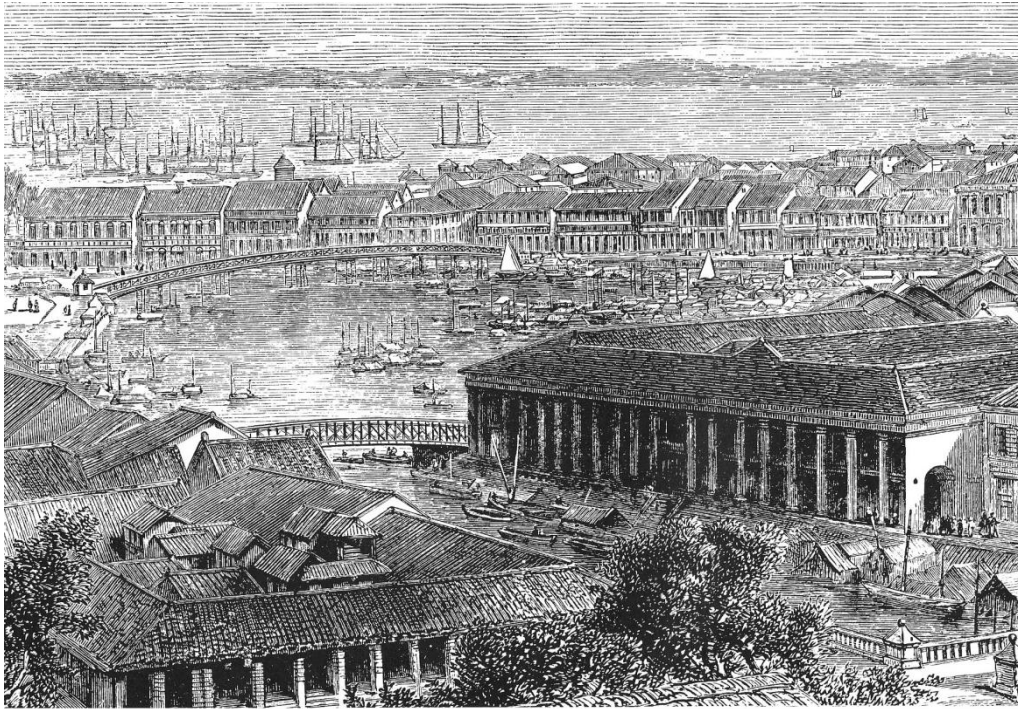
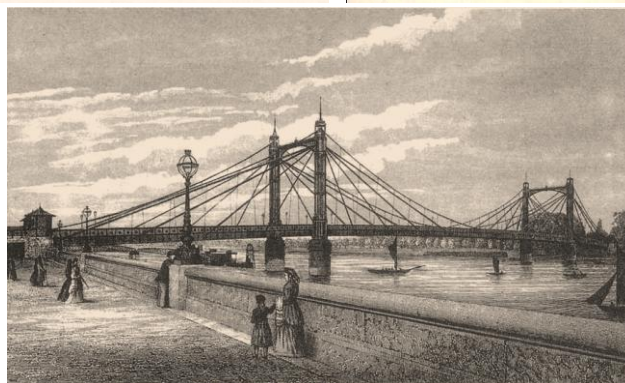
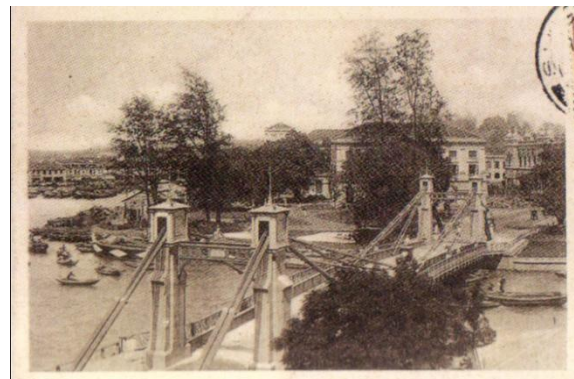


Fig 19: Drawing of Singapore River published in Bickmore's Travels in the East Indian Archipelago (1868). It shows the first iron bridge in Singapore, Elgin Bridge (mid-ground) and a wooden pedestrian footbridge at Bonham Street. (background) The bridge in the foreground is the 2nd Coleman Bridge constructed with timber.



*Fig 20: Bridges designed by Rowland Mason Ordish
Clockwise: Stefanik Bridge (1868), Cavenagh Bridge (1869) and Albert Bridge (1873)*

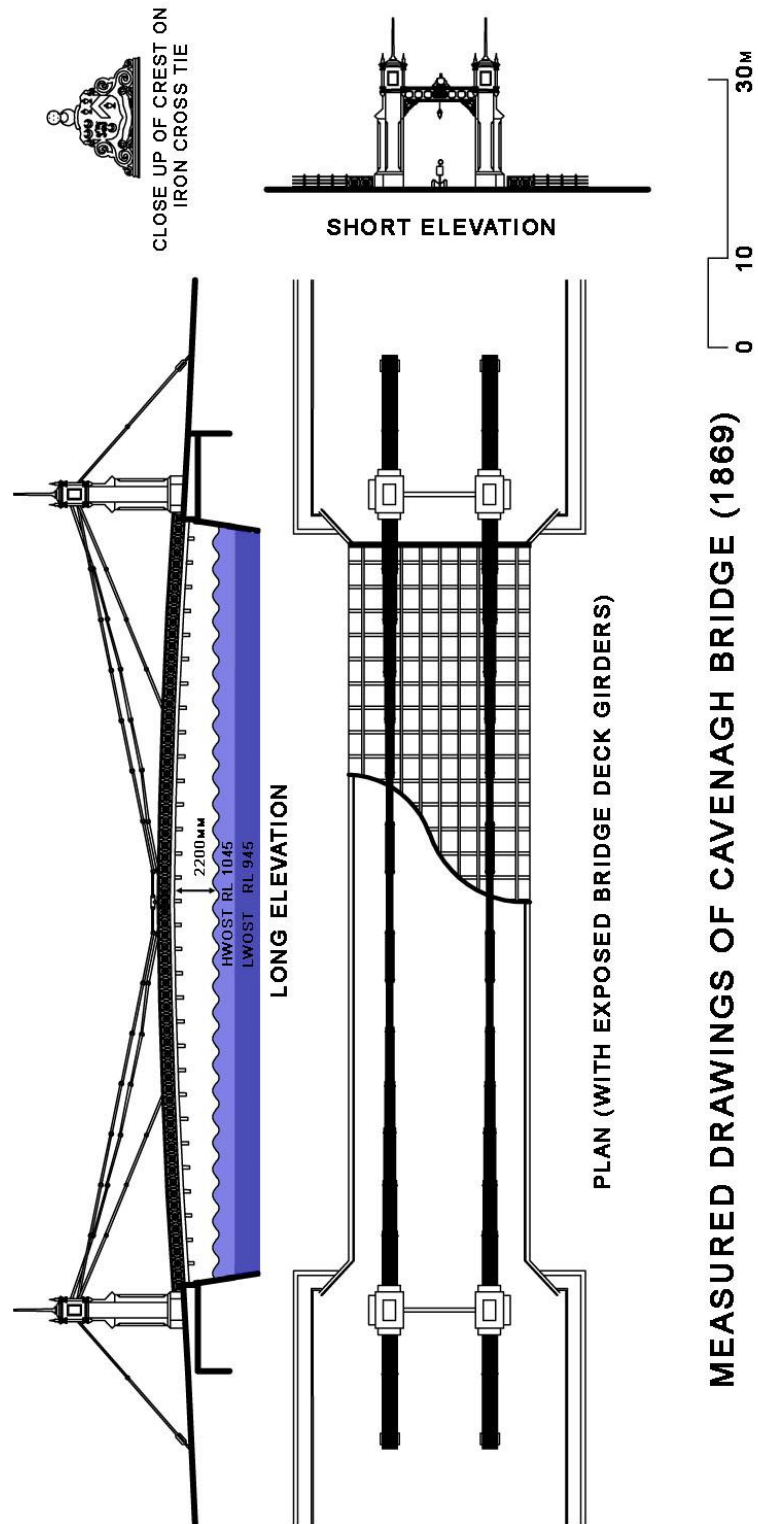


Fig 21: Measured Drawings of Cavenagh Bridge

The design of Cavenagh Bridge was executed in wrought iron to withstand the high tensile forces in the cables.¹²⁹ A loading test was conducted by manufacturer P&W MacLellan after completion. **(Fig 23)** Components of the bridge were bolted together and tested at Clutha Works in Glasgow *“with a double load equivalent to four times its own weight.”*¹³⁰ After the successful test, the components were shipped to Singapore and riveted on site by local labourers supervised by the Municipal Engineer. Live load testing was further conducted by *“a party of 120 Sepoys soldiers marching over the completed Cavenagh Bridge”*.¹³¹ Satisfied with its ability to withstand the load and movement of bullock carts and carriages, the engineer opened Cavenagh Bridge to the public in November 1868.

The second oldest extant historic bridge, Ord Bridge, stood out from the other bridges in terms of its design and origins. **(Fig 24)** The truss girder bridge, constructed in 1886, was not custom-designed. Instead, the bridge structure had been designed for the Indian railways. It *“was made by the mile, cut off to the length required and despatched by the Indian Railways”*.¹³² The vague description given in the Municipal report did not state the manufacturer, the type of iron used or how it arrived in Singapore. Judging from its year of completion, the bridge is probably made of wrought iron. The trusses in Ord Bridge are arranged in a Double Warren system that gave the girders a distinctive X shape. Each pair of cross girder is made of two inclined tension members held between two horizontal bars which prevent the cross members from moving during loading.¹³³ **(Fig 25)** The bridge had a single span of 135 feet (40.5m) and a width of 24 feet (7.3m). The width corresponds to the *“double track, British standard 1.435 meter gauge”* railway bridges which were mass produced for Indian railways.¹³⁴ Ord Bridge could have been made by one of the several British

¹²⁹ Benett (1999) *The Creation of Bridges*, Aurum Press Ltd, London, pp81-2

¹³⁰ Moss and Hume(2001), *Bridge Building Achievements of P&W MacLellan*, in *Transactions of Newcomen Society*, Vol 72, p183

¹³¹ Friday 22 Oct, *Straits Times Overland Journal*, 26 Oct 1869, p13

¹³² Ord Bridge, *The Straits Times*, 23 Aug 1886, p2

¹³³ Benett (1999) *The Creation of Bridges*, Aurum Press Ltd, London, p77

¹³⁴ Headrick (1988) *The Tentacles of Progress*, Oxford University Press, New York, p62

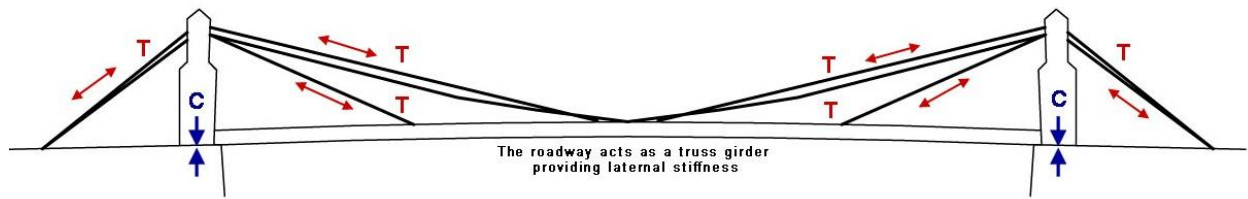


Fig 22: Load Bearing Diagram of Cavenagh Bridge

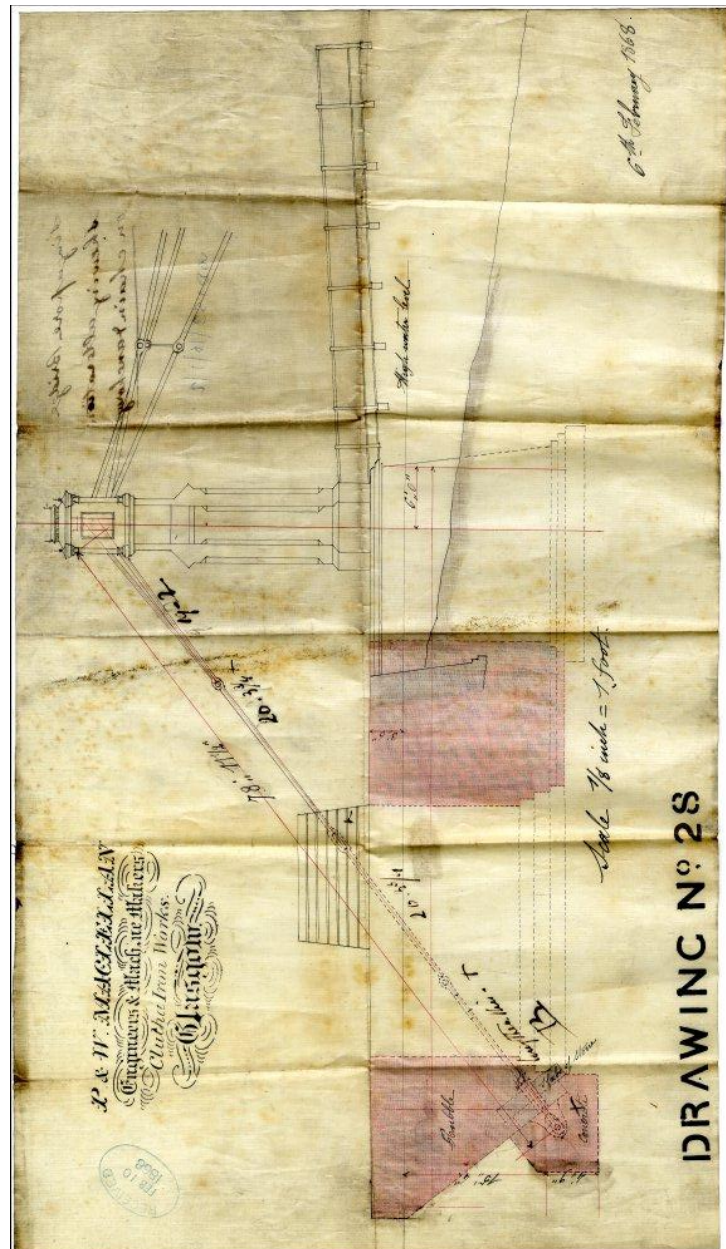


Fig 23: Drawing of Cavenagh Bridge by P&W MacLellan Ltd in Glasgow

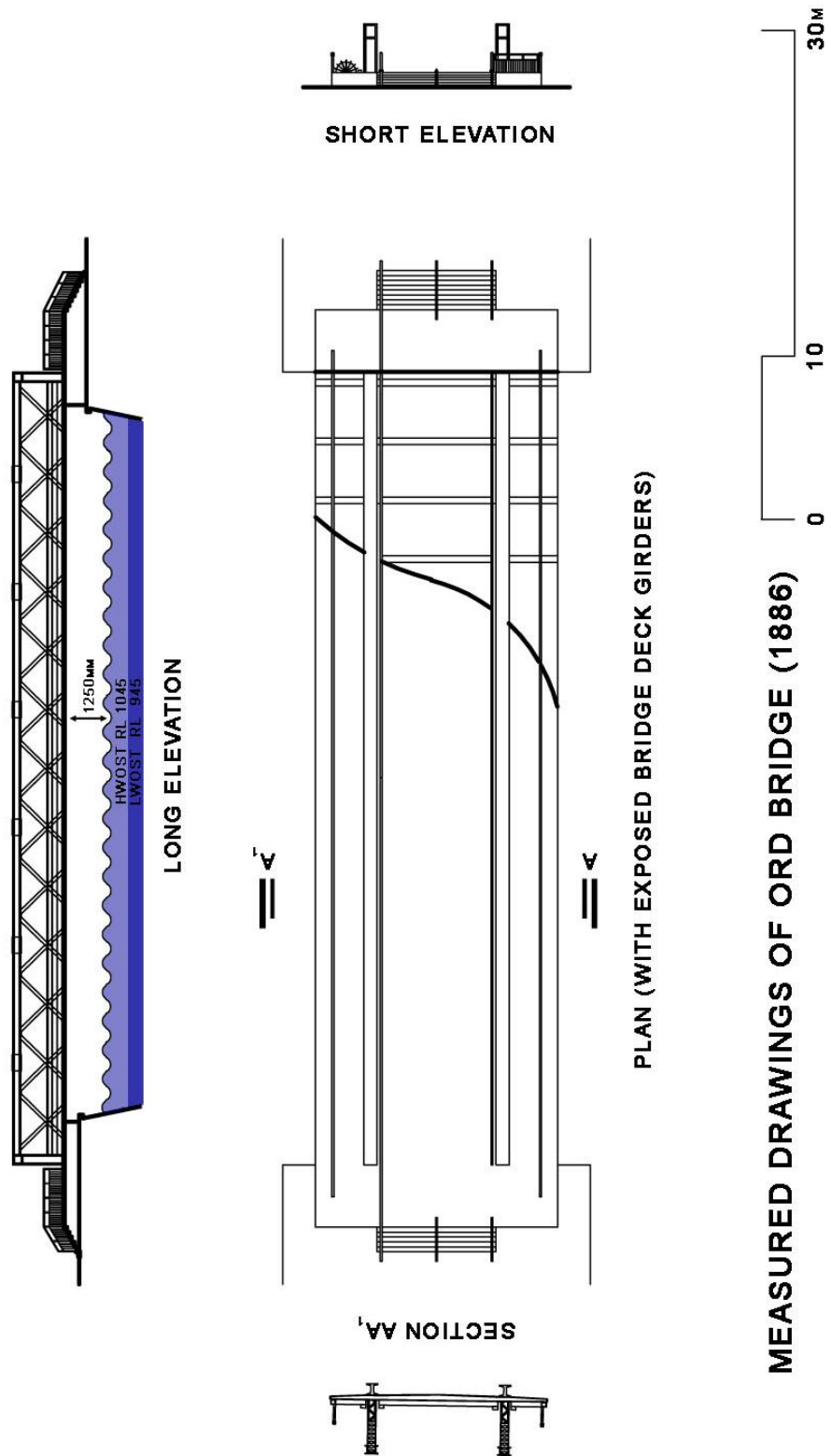


Fig 24: Measured Drawings of Ord Bridge

iron foundries awarded Indian railway contracts. These include Vulcan Foundry, Kitson and Company and P&W MacLellan.¹³⁵

By early 20th century, steel had replaced wrought iron as the preferred material for bridge construction. It offered greater compressive strength than wrought iron and was not susceptible to brittle failure like cast iron.¹³⁶ However it took a while for steel to supersede iron due to its high cost of manufacturing. By 1880, the world price of steel had dropped 75%, making it a viable alternative to iron.¹³⁷ The superiority of steel over iron allowed for longer spans and more variety in structural designs. Of the five historic bridges, Anderson Bridge was the first to be built with steel (1910). This was followed by the second Elgin Bridge (1929) and the second Read Bridge (1931). Three structural systems – steel truss arch, bowstring arch and the steel box girder, were used respectively. The changes in structural systems reflected engineering trends in Britain during that period. Stronger steel was continuously developed and the potential of using steel with concrete was realised. As a result, steel arch bridges were gradually replaced by steel plate girder bridges and reinforced concrete bridges.¹³⁸

Anderson Bridge has a span of 204 feet (61.2m) with 2 roadways of 31 feet 6 inches (24.5m) wide. **(Fig 26)** The roadways are flanked by three large steel girder arches, each reaching a top height of 20 feet (6m). Four classical arch portals, constructed with granite and plastered over, form the entrances to the two pedestrian walkways cantilevering from the main structure. Electric trams lines were also laid across each roadway to provide public transport between the Government and Commercial district.¹³⁹

The bridge is constructed on the “*Linville*” bowstring truss principle, whereby the girders in each arch were arranged “*in a curve rising to 26 feet high in the centre*”. The girders were then

¹³⁵ Headrick (1988) *The Tentacles of Progress*, Oxford University Press, New York, pp74-5

¹³⁶ Beckman and Bowles (2004) *Structural Aspects of Building Conservation*, Elsevier, London, pp205-6

¹³⁷ Benett (1999) *The Creation of Bridges*, Aurum Press Ltd, London, p39

¹³⁸ Benett (1999) *The Creation of Bridges*, Aurum Press Ltd, London, p34

¹³⁹ Tramway Lines, The Singapore Press, 12 Feb 2012, p7

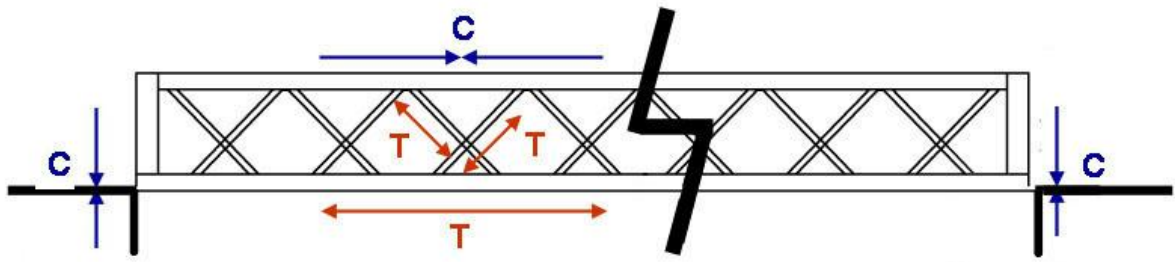


Fig 25: Structural Diagram of Ord Bridge

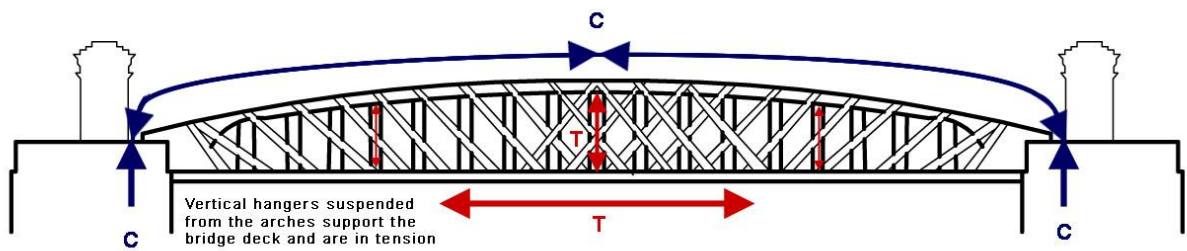


Fig 27: Structural Diagram of Anderson Bridge

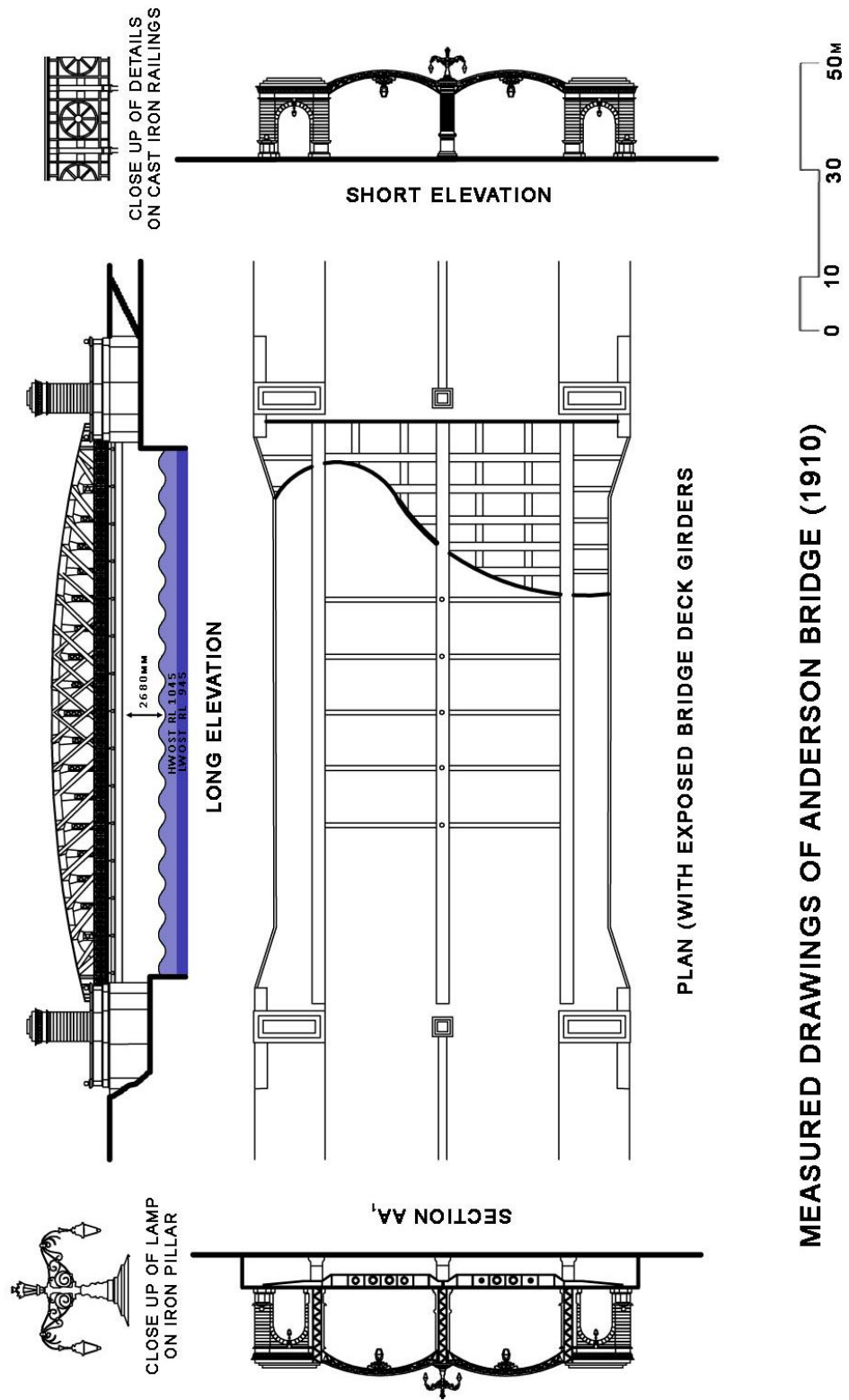


Fig 26: Measured Drawings of Anderson Bridge

rested onto a *“flat surface of steel cross girders spaced 10 feet apart”*.¹⁴⁰ **(Fig 27)** Steel arched ties adorned with bronze gas lamps, were used to secure the top of the arch girders together. The design of the steel girders and the stone portals of Anderson Bridge *“bear a close resemblance to Victoria Bridge over Brisbane River” in Australia*.¹⁴¹ **(Fig 28)** The latter was constructed in 1897 and was designed by A.B. Brandy, a bridge designer based in Sydney.¹⁴² Original construction drawings of Anderson Bridge did closely resemble Victoria Bridge but the ornamentation of Anderson Bridge was simplified during construction due to a lack of funds.¹⁴³

Similar to Cavenagh Bridge, the structural steelwork used for Anderson Bridge was manufactured in Britain and shipped to Singapore.¹⁴⁴ However the non-structural components, such as the *“iron castings, railings, rainwater channels, gully frames and covers were turned out at the Municipal workshops at River Valley Road.”*¹⁴⁵ This marked an important point in the colony’s engineering history. The colonial government sought to reduce its dependency on British engineering products and started to manufacture components for public works in-house.

The second Elgin Bridge, constructed in 1929, marked yet another step in the colonial government’s efforts to achieve engineering self-sufficiency. Instead of relying on consulting engineers in Britain to provide the design, the Colonial Government employed a bridge engineer in 1925 to design the bridges in-house. The engineer, T.C. Hood is remembered for his design of Crawford Bridge (1926), Elgin Bridge (1930) and Pulau Saigon Bridge (1940).¹⁴⁶ Elgin Bridge was based on Hood’s earlier design for Crawford Bridge. **(Fig 29)** It consisted of three steel bowstring arches encased in concrete. The span of Elgin Bridge (140 feet) is twice as long as Crawford Bridge.

¹⁴⁰ Anderson Bridge, The Straits Times, 1 July 1908, p7

¹⁴¹ *ibid*

¹⁴² Bridge Designer Dead, The Morning Bulletin, Rockhampton, 1 June 1932, archived by National Library of Australia, <http://trove.nla.gov.au/ndp/del/article/54742366?>

¹⁴³ Anderson Bridge, The Straits Times, 12 Mar 1910, p4

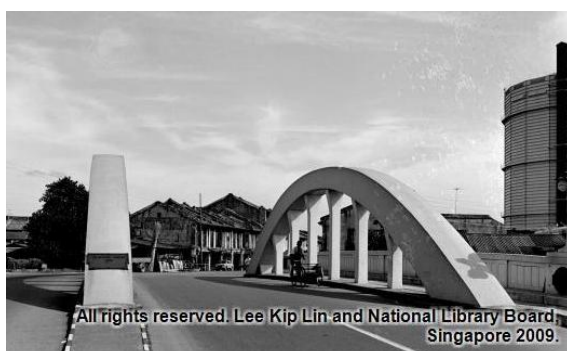
¹⁴⁴ *ibid*

¹⁴⁵ *ibid*

¹⁴⁶ Retirement of Mr. T C Hood, Malayan Saturday Post, 11 April 1931, p12



*Fig 28: Comparisons of Victoria Bridge (left) and Anderson Bridge
Top Row: The Front elevations of the bridges
Bottom Row: Details of the Stone Arches*



*Picture 29: Crawford Bridge (left) with free standing arches and
Elgin Bridge with cross ties between the three arches.*

The bridge deck is 86 feet (25.8m) wide to accommodate two roadways of 27 feet (8.1m) and two pedestrian sidewalks of 6 feet (1.8m) each. **(Fig 30)** The long span and width required for Elgin Bridge posed structural problems. Hood could not use the free-standing bowstring arches like those in Crawford Bridge. Instead, he had to design cross ties to *“resist the outwards thrust (from the arches) by tying them together”*.¹⁴⁷ **(Fig 31)**

The steel used for Elgin Bridge was manufactured in Britain by the Glasgow Steel Roofing Company Ltd. Details of the steel components were drawn by Hood and sent directly to the manufacturer. The drawings were then amended to fit manufacturing requirements.¹⁴⁸ **(Fig 32)** By excluding the consulting engineer and the Crown Agents, the cost of designing and importing the bridge was reduced significantly. Furthermore as the Bridge Engineer was based in Singapore, he had knowledge of Singapore River and was aware of the need to raise the new Elgin Bridge *“4 feet higher than the high water mark of the existing bridge”* to allow lighter boats to pass during high tide.¹⁴⁹ Earlier bridges designed by foreign engineers, such as Cavenagh Bridge and the first Read Bridge had *“insufficient height clearance and unsuitable design”* which prevented heavily laden lighter boats from passing through.¹⁵⁰

Hood had a preference for reinforced concrete bowstring bridges. During his term as Municipal Bridge Engineer, he designed three bridges with this system. Crawford Bridge (1926) and Elgin Bridge (1930) were realised but the design of Read Bridge (1931) was changed after Hood's retirement in 1931. Interestingly, the reinforced concrete bowstring system was also popular worldwide during the 1920s. Examples include Welney Bridge in Norwich (1926) and Guelph Bridge in Ontario (1920). There were two reasons for the preference. Firstly, the material had greater compressive strength compared to steel, thus allowing the bridge to take heavier vehicular loads. Secondly Hood observed that industries along Singapore River were releasing *“sulphuretted*

¹⁴⁷ Municipal Report, Singapore Free Press, 18 Oct 1929, p20

¹⁴⁸ See Elgin Bridge Indent Drawing SB55 and Glasgow Steel Roofing Drawing, SB 190 (PWD 00010)

¹⁴⁹ Singapore Bridges, Problem of Reconstruction, Singapore Free Press, 24 December 1925, p9

¹⁵⁰ Two Day's Journey Down River, The Straits Times, 8 Nov 1929, p13

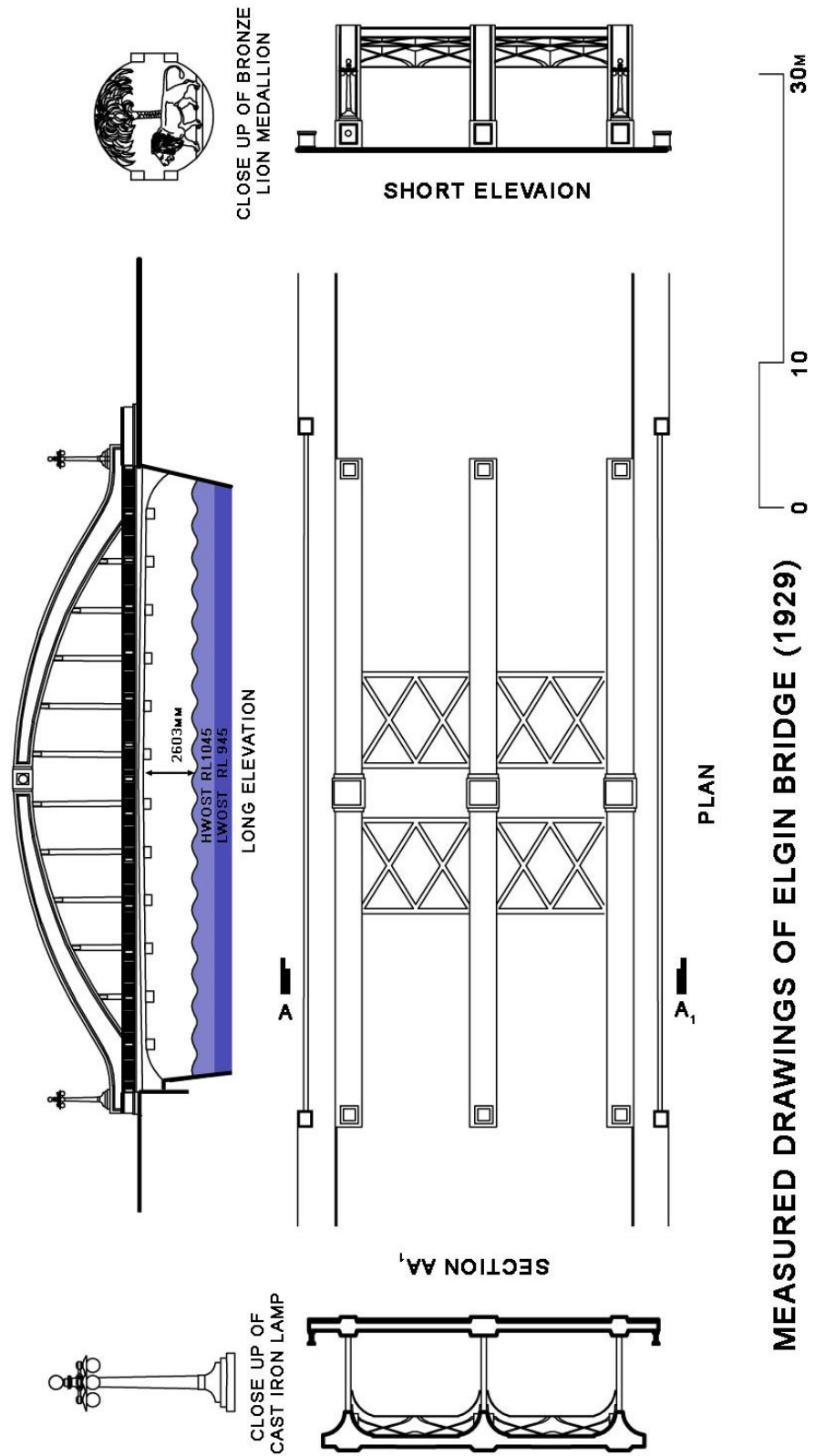


Fig 30: Measured Drawings of Elgin Bridge

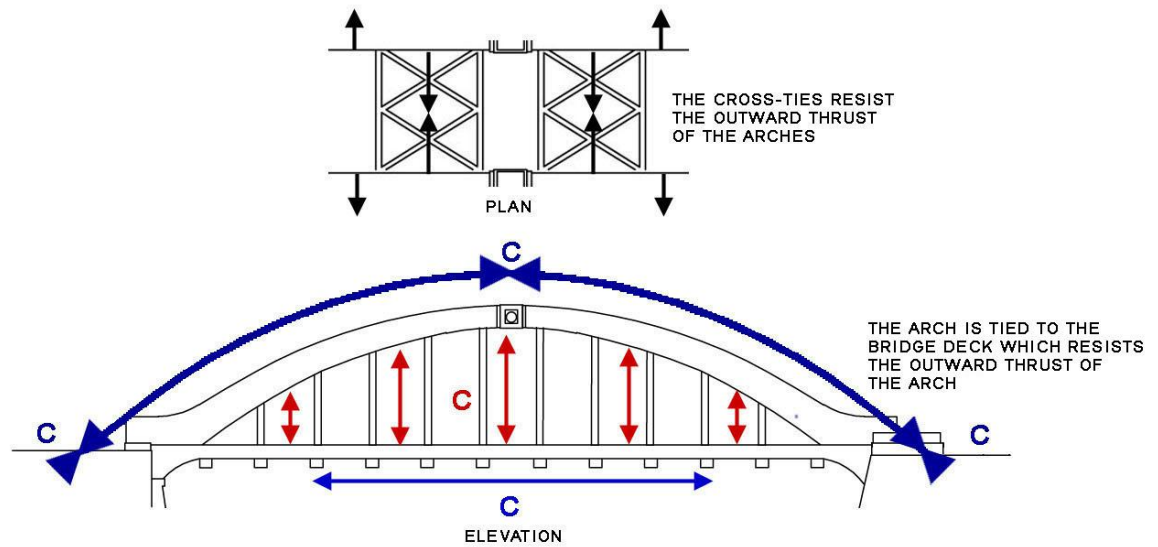


Fig 31: Structural Diagram of Elgin Bridge (1929)

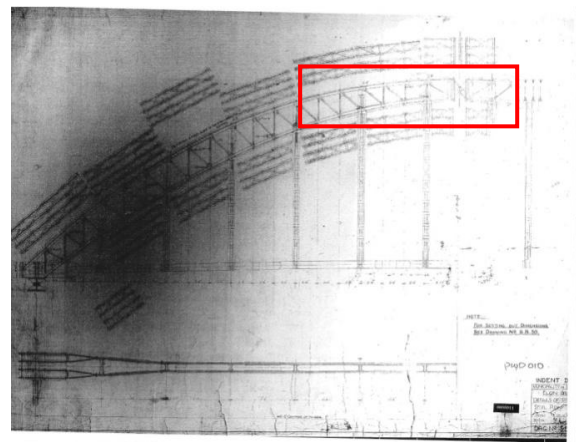
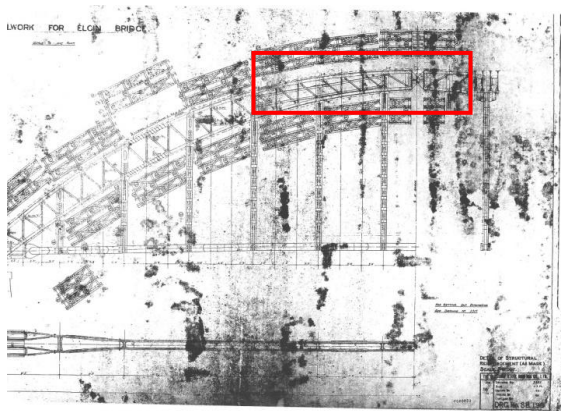


Fig 32: Comparison between the Manufacturer's (The Glasgow Steel Roofing Co) drawing and the design details drawn by TC Hood in 1926. Note the manufacturer's addition of cross bracing in the steel arches (boxed)

hydrogen” into the air. When combined with moisture, it formed sulphuric acid which “*caused heavy corrosion on steel bridges across the river.*”¹⁵¹ The concrete encasing the steel structure of Elgin Bridge thus served as a protective barrier against corrosion.

The second Read Bridge, built in 1931, was the last of the five extant historic bridges over Singapore River. Hood initially designed it as a single span reinforced concrete bowstring bridge. However it was eventually built as a steel box girder bridge.¹⁵² **(Fig 33)** As the reconstruction of Read Bridge occurred during the Great Depression, the project was directly affected by cuts in public works funds. The majority of the funds were also diverted away to the Civil Aerodrome construction, considered then to be the colony’s principal infrastructure development.¹⁵³ Hence, Read Bridge was redesigned to fit the reduced budget.

There were three economic reasons for the design change. Firstly, the old Read Bridge had two spans. There was a concrete pier in the middle of the river to support the iron girder bridge. The new Read Bridge integrated the pier into its design to avoid the cost of demolishing it. Secondly, as the new Read Bridge was redesigned with two spans of 77 feet (24m), the relatively short spans was suitable for implementing the steel box girder system.¹⁵⁴ **(Fig 34)** The shallow design of the structural system also provided sufficient clearance under the bridge for lighter boats to pass through.¹⁵⁵ Thirdly, the new design required less steel, thus reducing the manufacturing cost. **(Fig 35)**

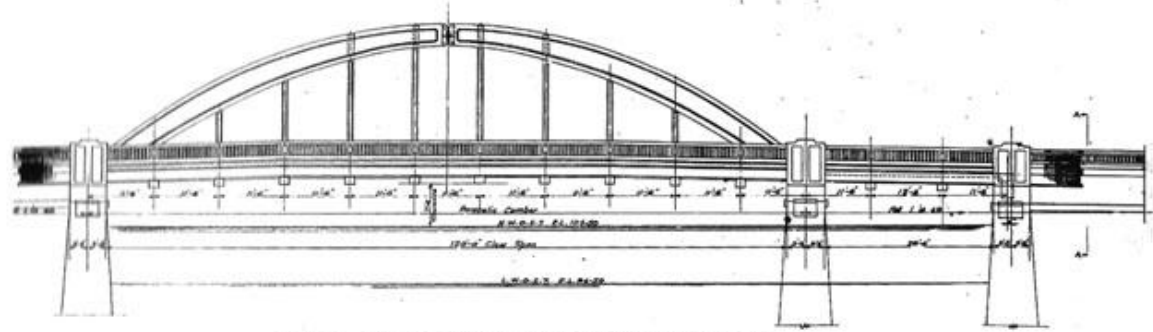
¹⁵¹ Singapore River Smell Corrodes Bridge, The Straits Times, 17 Apr 1939, p13

¹⁵² See Municipal Drawing of Read Bridge, SB 260 (1929) and Municipal Drawing of Read Bridge SB 306 (1931)

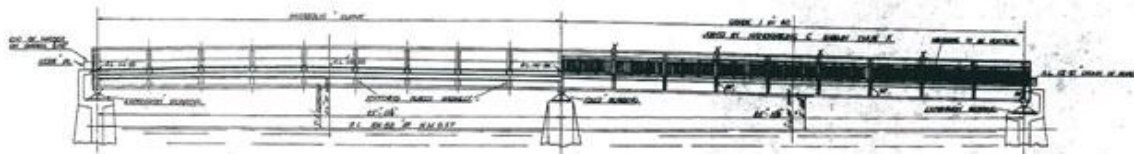
¹⁵³ Slump Effects in the Colony, Singapore Free Press, 29 Sep 1931, p7

¹⁵⁴ Benett (1999) The Creation of Bridges, Aurum Press Ltd, London, pp78-9

¹⁵⁵ Two Day’s Journey Down River, The Straits Times, 8 Nov 1929, p13

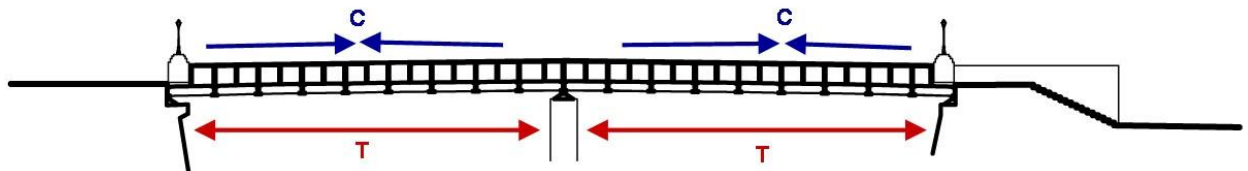


INITIAL DESIGN OF READ BRIDGE (JAN 1930)



FINALISED DESIGN OF READ BRIDGE (SEP 1930)

Fig 33: Initial and Final Design Drawings of Read Bridge



When a load is applied onto the bridge deck, it acts as a beam supported by the abutments and piers. The top half above the neutral axis will be compressed whereas the bottom half will be stretched and will go into tension.

Fig 34: Structural Diagram of Read Bridge

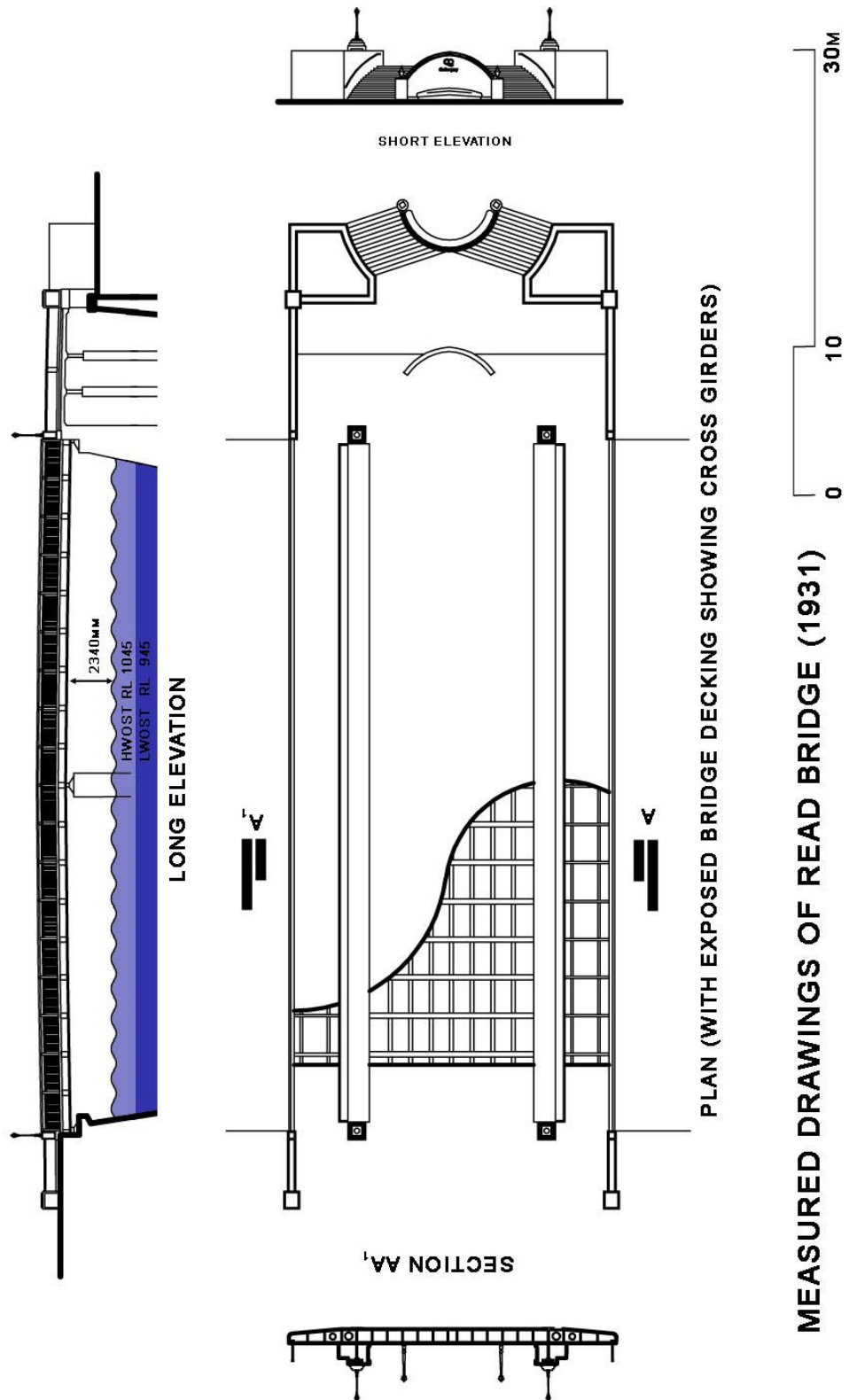


Fig 35: Measured Drawings of Read Bridge

The steelwork for the bridge was manufactured by a British firm, Motherwell Bridge and Engineering Co Ltd, in 1930 to the design of K.G.M. Fraser, Municipal Engineer of Singapore.¹⁵⁶ Correctly anticipated by his predecessor, T.C. Hood, Read Bridge started to corrode after its completion in September 1931. By the end of the decade, the bridge had suffered “*exceptionally heavy corrosion, despite being designed with particular care*”.¹⁵⁷ Further corrosion of Read Bridge over the years resulted in an extensive structural repair in 1991.¹⁵⁸ Two structural steel beams delineating the roadway and pedestrian sidewalks on the bridge were encased in concrete to prevent further corrosion damage to the steel structure. **(Fig 36)**

CONSTRUCTION METHODS AND DISRUPTION TO RIVER TRAFFIC

The duration of disruption to river traffic played a crucial role in the structural designs and construction methods of the historic bridges. The previous section had shown how macro factors, such as the height clearance under the bridges and its maximum load could affect the structure, material and span of the bridge. **(Fig 37)** Similarly, the construction of bridges on Singapore River would also affect its traffic and trade. Thus, the bridges had to be constructed within the shortest period of time possible to minimise disruption to river traffic between the outer and inner harbour of Singapore River. This section will look at the construction process of three of these historic bridges over Singapore River—Cavenagh Bridge (1868), Anderson Bridge (1910) and Elgin Bridge (1929). In particular, it will focus on how the metal structures were assembled and the different methods used to move the structure across the river.

¹⁵⁶ See Municipality of Singapore, Read Bridge Drawing, SB 306 and Motherwell Bridge and Engineering Co Ltd, Steelwork of Read Bridge SB 275

¹⁵⁷ Engineers Inspect New Bridge, The Straits Times, 16 April 1939, p3

¹⁵⁸ Three roads closed for good, The Straits Times, 14 Nov 1991, p19



Fig 36: Comparison of Steel Beams on Read Bridge (1983) and the encased beams in 2012

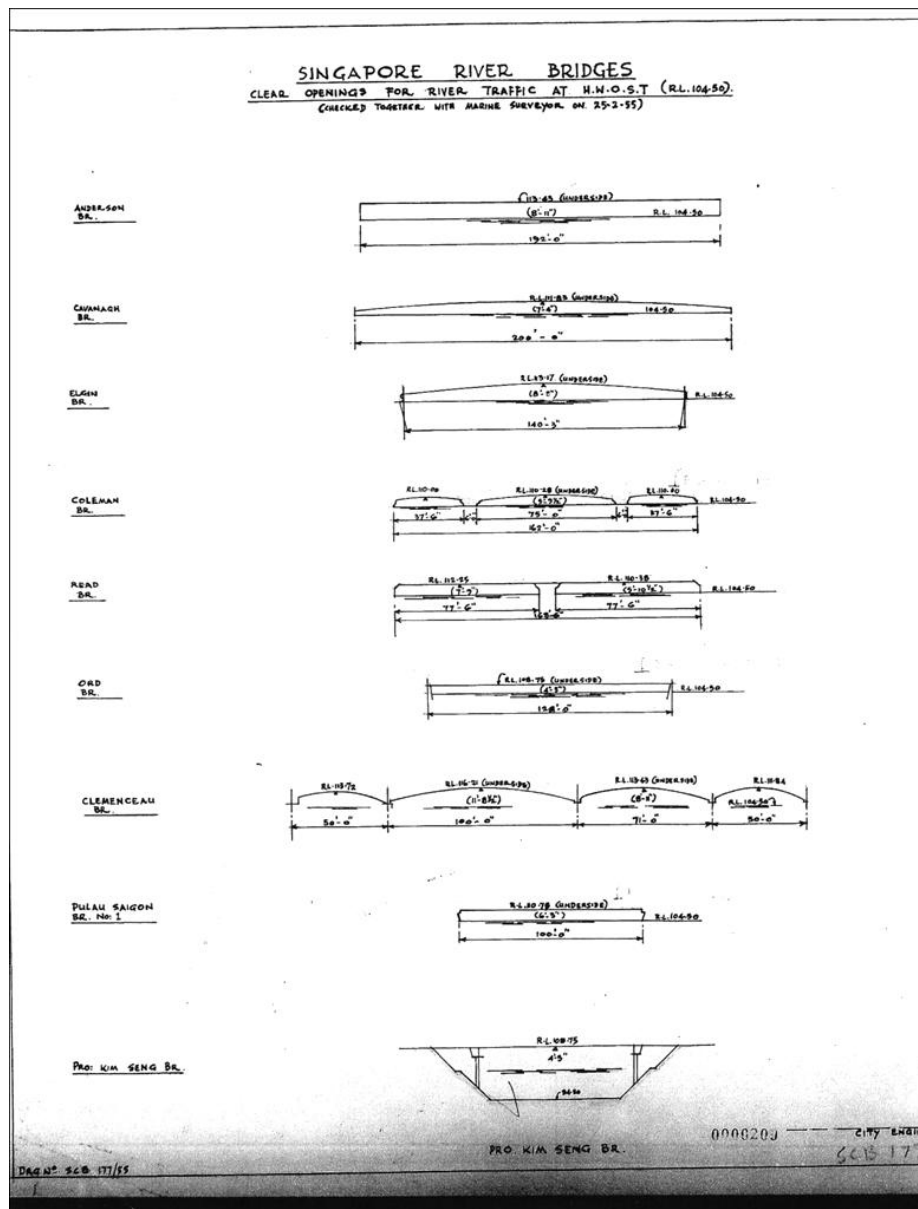


Fig 37: Height Clearance and Spans of Singapore River Bridges (1955)

A photograph taken in 1888 showed the construction progress of the first Read Bridge. **(Fig 38)** A large empty field next to the bridge was set aside for the erection of the bridge deck and the arches of the bridge. In the picture, the cross girders of the bridge deck had been installed across the river while other components were stacked neatly on the open field. The picture showed an example of how iron bridges in colonial Singapore were constructed. Components were manufactured in Britain and shipped to Singapore in flat and small sections. The components were compact in size to fit the cargo hold of 19th century steamships. As the tonnage of steamships rose rapidly in the late 19th century, the cargo hold could accommodate larger prefabricated components. Surveys conducted on Suez Canal showed the average tonnage of passing ships rising from 1,348 in 1870 to 2,877 in 1890 and to 5,086 in 1910.¹⁵⁹

Disruption to river traffic was inevitable during the construction of the bridges. However as construction technology advanced from the late 19th to early 20th century, the duration of disruption was reduced from three months to just one day. The reduction was due to the different techniques used to erect the structure and to move it across the river.

During Cavenagh Bridge's construction in 1868, a timber staging was erected.¹⁶⁰ The design of the suspension bridge required the bridge deck to be constructed before the suspension cables could be riveted to the deck and secured to the four masonry towers. During the construction, the timber staging and the metal bridge deck were exposed to the constant *"striking and bumping by large and heavily laden lighters"*.¹⁶¹ As a result, the Municipal Engineer had to order the closure of the river near the bridge. River traffic was reduced to *"an opening on either side of the cofferdams for boats of light draft, not more than two coyans (~2720 kg)¹⁶² to pass through"*.¹⁶³ The three month period of construction from April to July 1869 caused considerable disruption to river traffic. Once

¹⁵⁹ Headrick (1988) *The Tentacles of Progress*, Oxford University Press, New York, p277-289

¹⁶⁰ *The New Bridge*, *The Straits Times*, 5 April 1909, p7

¹⁶¹ Municipal Council, *The Straits Times*, 17 April 1869, p2

¹⁶² A coyan is a unit of mass in SE Asia, 1 coyan is 3098 pounds (~1360 kg)

¹⁶³ *ibid*



Fig 38: Construction of the first Read Bridge (1889)



Fig 39: The top picture shows the steel skeleton of Elgin Bridge assembled on the North Bank ready to be hoisted across the river. The bottom picture shows the completed reinforced concrete bridge.

the engineer certified that the bridge was held up entirely by the chains, the Municipal Commissioners immediately ordered the removal of the timber staging and to have *“free navigation of the river restored”*.¹⁶⁴

Learning from the experience of Cavenagh Bridge, disruption to the river traffic during Anderson Bridge’s construction was reduced to one week. The construction work was separated into two parts. Firstly, the three bowstring arch girders were assembled *“on the vacant grounds on the north side of the river”*.¹⁶⁵ Concurrently, the local contractor firm, Messrs Howarth Erskine built a temporary track system for the girders to be hauled over the river. The system was *“built upon five piers driven into the bed of the river. Heavy steel joists were then placed from pier to pier to act as longitudinal beams. These carry the cross joists which supported the two longitudinal sleepers which in turn carried the rails on which the wheels of bogies run.”*¹⁶⁶ Before installing the girders of Anderson Bridge, the bogies were placed beneath the girders on shore. A *“13-horse power winding engine coupled to a steel wire rope”* was then used to haul each of the three 250-ton deck arch girders across the river.¹⁶⁷

At 6am on Sunday, 4 April 1906, the girders were hauled across the river from the North Bank after weeks of preparation.¹⁶⁸ As river traffic had to be completely closed during the move, the time and day of the works was chosen to ensure the least disruption. The downstream girder was hauled first to its intended position, followed by the upstream girder and then the heavier 300-ton central girder.¹⁶⁹ A Municipal Report after the construction period noted *“very little interruption to the river traffic”*.¹⁷⁰ The report also gave details to why this method was chosen over *“floating the girders across the river.”* Two reasons were given. Firstly, the low tide in the early morning would not have permitted pontoons to lift the girders off the shore. Secondly, the engineer, Robert Peirce had

¹⁶⁴ Municipal Engineer Report, The Straits Times, 31 July 1868, p2

¹⁶⁵ Interesting details of Anderson Bridge’s new structure 20 Aug 1909, p7

¹⁶⁶ First girder placed over the river, The Straits Times, 5 Apr 1909, p7

¹⁶⁷ *ibid*

¹⁶⁸ *ibid*

¹⁶⁹ *ibid*

¹⁷⁰ Municipal Report, The Singapore Free Press, 20 Aug 1909, p6

considered that *“the temporary construction operation could be largely effected on terra firma”*, thereby causing minimal disruption to the river traffic.¹⁷¹

In contrast to Pierce’s rationale, the superstructure of the second Elgin Bridge was transported across the river by pontoons in 1928. Engineering technology had progressed since Anderson Bridge’s construction in 1906, so the use of pontoon did not cause much disruption to river traffic. In fact, despite *“drawing the steel bridge across as one complete structure”*, the river was only closed to traffic for one day.¹⁷² As in the preparation work of Anderson Bridge, the steel assembly was conducted on land. The components were assembled on an open space on the north bank of the river to form the complete 146 feet (44m) long, 80 feet (24m) wide and 30 feet (9m) high steel skeleton for the reinforced concrete bridge.¹⁷³ **(Fig 39)**

On the afternoon of 30 October 1928, river traffic was stopped to commence the moving of Elgin Bridge. Two hopper barges were lashed together side by side to form a pontoon. **(Fig 40)** During low tide, the pontoon was *“moved into position below the overhanging steelwork and the rising water slowly raised the pontoon until it touched the steelwork”*.¹⁷⁴ As the tide rose *“a further two and a half feet”*, one end of the steel structure was gradually lifted off its supports on the North Bank and was carried by the pontoon towards the South Bank.¹⁷⁵ Workers then used cables and winches to slowly guide the structure to its intended position on the granite abutment. As the tide subsided in the evening, the structure slowly settled into position.¹⁷⁶ **(Fig 41)**

¹⁷¹ *ibid*

¹⁷² *Erection of Elgin’s Superstructure*, The Singapore Free Press, 31 Oct 1928, p11

¹⁷³ *Elgin Bridge Problem*, The Straits Times, 28 Oct 1929, p11

¹⁷⁴ *ibid*

¹⁷⁵ *Erection of Elgin’s Superstructure*, The Singapore Free Press, 31 Oct 1928, p11

¹⁷⁶ *ibid*

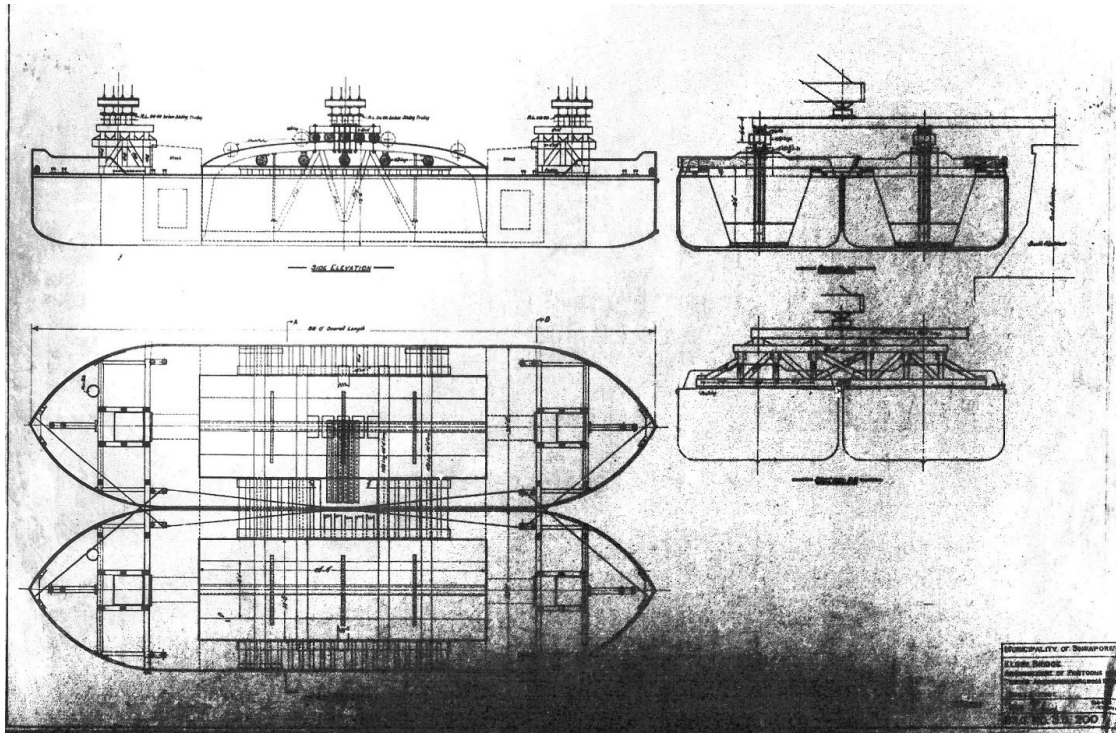


Fig 40: Diagram showing the arrangement of the pontoon carrying Elgin Bridge across the river.

THE NEW ELGIN BRIDGE NEARING COMPLETION



Owing to the river traffic the building of the superstructure of this bridge was a difficult operation. The frame-work was put together on the northern bank and on Tuesday this week it was hauled across on barges. The bridge has a 140 ft. span.



Placing the superstructure in position. Mr. T. C. Hood, the Municipal bridge engineer, who designed and constructed the bridge is in the centre.

Fig 41: Newspaper report on hoisting the steel skeleton.
The barges (left, top picture) are used to hoist the bridge across the river

T.C Hood, the designer of Elgin Bridge, readily admitted that the structure “could have been done by laying the massive steel girder separately across the river”.¹⁷⁷ Despite the heavier load for the pontoon method, it was eventually chosen due to its much shorter period of disruption to river traffic.¹⁷⁸

HOLISTIC APPROACH TO UNDERSTANDING THE BRIDGES’ HISTORY

This dissertation had adopted a holistic approach to the task of understanding the five historic bridges. This chapter has shown how the process of technology transfer from Britain to Singapore was not a simply a response to the need for modernisation. Instead, the development of bridge construction in colonial Singapore was driven by global and macro factors such as politics and trade. Furthermore, we also saw how the structural design and construction methods of the bridges were determined by tangible considerations such as the environment of the river and the disruption to river traffic, and intangible factors such as the design preferences of the engineers and the popularity of different structural systems during the 19th and 20th century. **(Fig 42)**

This holistic approach had shown that the study of bridge engineering must be set in an appropriate social and economic context in order to be comprehensive. Beyond just understanding this complex process, it is also important to consider how this knowledge could enable policy-makers to enhance their conservation strategies for the five historic bridges and other “functional heritage” structures. The concluding chapter will evaluate the potential application of this holistic approach in conservation and show how a balance could be struck between the functional requirements of the bridges and the need to conserve their structural and aesthetic qualities.

¹⁷⁷ The New Elgin Bridge Nearing Completion, Malayan Saturday Post, 3 Nov 1928, p36

¹⁷⁸ *ibid*

BRIDGE STRUCTURES AND POPULARITY

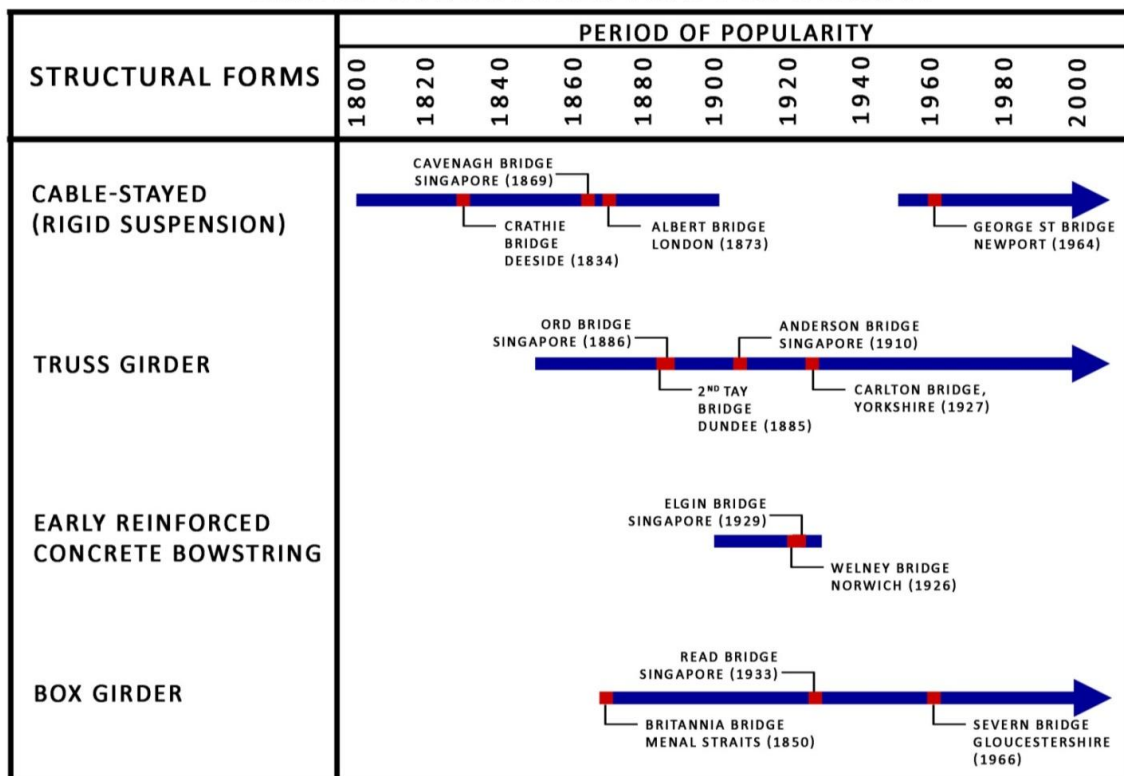


Fig 42: Popularity of different structural systems for bridges in the 19th to 21th century



Fig 43: Demolition of shophouses near Coleman Bridge in 1980

CHAPTER FIVE: CONSERVATION

A HISTORY OF CONSERVATION AT SINGAPORE RIVER

In an interview given in 1986 by the former Deputy Prime Minister of Singapore, S Rajarathnam, he discussed the reasons for the change in perception towards conservation in the 1980s:

*“Singapore 25 years ago was a real slum; we decided to renew the city. Through the heady years of independence and world-leading growth, Singaporeans went about with a rare will. But the technocrats, got really enthusiastic about knocking things down. The thinking was everything that’s old, knock it down. Gradually, some of us realised that it is not our urban renewal: It is a kind of distortion”.*¹⁷⁹

Singapore underwent rapid redevelopment during the 1960s and 1970s. In the process of urban renewal, many old buildings were demolished. This resulted in an abrupt disappearance of historic buildings and the subsequent proliferation of skyscrapers in the city. The phenomenon was apparent around Singapore River as low-rise office buildings and shophouses in the commercial district made way for modern high-rise. **(Fig 43)**

The possibility of significant losses to Singapore’s architectural heritage and historic fabric caught people’s attention. This increased the government’s awareness of the need to conserve historic areas as it realized the importance of such places in fostering national identity.¹⁸⁰ After a decade-long beautification and conservation project, the new Singapore River was conceptualized as a showcase of *“Singapore’s rich, multi-ethnic origins”* in the Urban Redevelopment Authority’s (URA)

¹⁷⁹ Asiaweek, September 1986, quoted by Yuen and Ng (2001) Urban Conservation in Singapore: Tradition or Tourist Bane, Planning Practice and Research, Vol 16 No 1, p41

¹⁸⁰ Chan (2005) Conservation and Change—A Singapore Case of Urban Conservation and Development, 15th ICOMOS General Assembly and International Symposium: ‘Monuments and sites in their setting, 17 – 21 Oct 2005

1991 Concept Plan.¹⁸¹ Plans for the area were then elaborated in the Singapore River Planning Area Report 1994. Three conservation sub-zones, Boat Quay, Clarke Quay and Robertson Quay, were formed.¹⁸² Although each area had a different focus, the common objective was to *“restore and adapt the historic buildings to accommodate new uses in the 21st century”*.¹⁸³

The warehouses and shophouses were restored and adapted for new commercial purposes. Even though the facades were retained, the practice of adaptive-reuse was heavily criticised as creating *“pastiche motifs of the past, rather than receptacles of collective memory”*.¹⁸⁴ The revitalised townscape may not bear any relevance to the old riverine trade; yet undeniably, the conservation of Singapore River had fulfilled the government’s twin aims of *“protecting a historical landscape of national importance”* and creating a new *“resource of recreational value”*.¹⁸⁵

PAST CONSERVATION OF THE HISTORIC BRIDGES

Similar to the conserved buildings, the five historic bridges over Singapore River were featured in the Planning Report as key urban elements that *“reflected the historical character of the area”*.¹⁸⁶ During the 1980s and 1990s, the five historic bridges were conserved and strengthened to meet functional requirements. As part of urban renewal, Cavenagh Bridge, Read Bridge and Ord Bridges were converted to pedestrian use whereas Elgin, Anderson and Coleman Bridges remained open to vehicles. Accordingly, studies were conducted to ascertain their loading capacities to meet traffic demands. A series of specific structural interventions, ranging from maximum retention of the

¹⁸¹ Asiaweek, September 1986, quoted by Yuen and Ng (2001) Urban Conservation in Singapore: Tradition or Tourist Bane, Planning Practice and Research, Vol 16 No 1, p42

¹⁸² URA (1994) Singapore River Planning Area Planning Report, Urban Redevelopment Authority, Singapore, p5

¹⁸³ Speech by Dr John Chen, Minister of State for Communication and Information Technology, 18 July 2001

¹⁸⁴ Jones and Shaw (2006) Palimpsests of Progress: Erasing the Past and Rewriting the Future in Developing Societies, International Journal of Heritage Studies, Vol 12, No.2, Mar 2006, p200

¹⁸⁵ Dobbs (2003) The Singapore River, A Social History 1819-2002, Singapore University Press, Singapore, p122

¹⁸⁶ URA (1994) Singapore River Planning Area Planning Report, Urban Redevelopment Authority, Singapore, p14

structure, structural reinforcement and reconstruction, were conducted on Cavenagh, Anderson and Coleman Bridges respectively.

The objective of the Cavenagh Bridge restoration was to strengthen it to meet “*the design load of 5KN/m² for pedestrian bridge*”.¹⁸⁷ The bridge structure was dismantled and each component was inspected and repaired before reassembly. Components “*beyond repair*”, such as the main suspension girders and the bearings, had to be replaced. The original fabric was retained as much as possible and the structural design of the bridge remained unchanged. **(Fig 44)**

As a road bridge, the loading requirements for Anderson Bridge were higher than that of Cavenagh Bridge. Therefore, the restoration process was more extensive. The works occurred in two phases. Firstly, the bridge structure was strengthened with additional beam reinforcements to meet loading requirements.¹⁸⁸ Secondly, as the weight and frequency of vehicles crossing the bridge increase, there was higher risk of damage to the structure. The Esplanade Bridge was hence constructed in 1994 to alleviate city congestion and to divert traffic away from the historic bridge.¹⁸⁹ **(Fig 45)** The weight of vehicles crossing Anderson Bridge was also restricted to less than 10 tonnes.¹⁹⁰

New Bridge Road, where Coleman Bridge is situated, was designated as a major arterial road in URA’s Planning Report. The original iron bridge would not be able to cope with the intended heavy traffic load and had to be rebuilt. The new reinforced concrete bridge was “*designed to keep the character of its predecessor*”.¹⁹¹ The three span design of the old bridge was replicated and the cast iron railings and lampposts were retained. The new bridge, although executed in a different material, was faithfully constructed in its predecessor’s image. **(Fig 46)**

¹⁸⁷ Interview with Seah Chong Beng, Higher Principal Engineer Officer (Central 1), 21 May 2012

¹⁸⁸ *ibid*

¹⁸⁹ Marina Bay Bridge will relieve traffic congestion, The Straits Times, 3 July 1994, p23

¹⁹⁰ Interview with Seah Chong Beng, Higher Principal Engineer Officer (Central 1), 21 May 2012

¹⁹¹ Cheong (1992) Framework and Foundation, Times Edition, Public Works Department, pp53-54



Cavenagh Bridge gets extra support.

Fig 44: Props added beneath Cavenagh Bridge as part of the restoration exercise



Fig 45: Esplanade Bridge (left) built in 1994 to divert heavy traffic away from Anderson Bridge (right)

The conservation of the historic bridges conducted by the Public Works Department from 1985 to 1995 focused on rehabilitating the structures to meet functional requirements. The image of the bridges was retained but extensive and irreversible alterations to the structures, such as the addition of new structural elements and even reconstruction, had been carried out.

AN INTEGRATIVE APPROACH TO BRIDGE CONSERVATION

A more sensitive approach for future conservation of historic bridges was attempted after 2008, when the five bridges were gazetted as “*conserved structures*”.¹⁹² Under URA’s conservation management, its “*3R principles—Maximum Retention, Sensitive Restoration and Careful Repair*”, would be applied for future major works on the bridges.¹⁹³ There would be an emphasis on retaining the original structural design of the bridges and as such “*the addition of visible supporting structures to increase performance*” would be preferable to “*a major change of structural systems for the historic bridges to increase loading strength*”.¹⁹⁴

Over and above the principles prescribed by URA’s conservation guidelines, a holistic conservation approach which considered both the technological and social aspects of the bridges would enhance conservation strategies for the five historic bridges.

At the micro scale, conservators with a deeper understanding of the structural systems and materials used in the five historic bridges could make informed and acceptable conservation decisions.¹⁹⁵ This would involve balancing the extent of bridge repairs to retain the integrity of the

¹⁹² Twelve Iconic Structures, The Straits Times, 4 Oct 2008, p A61

¹⁹³ Interview with Kelvin Ang, Deputy Director of Conservation Management Department, Urban Redevelopment Board Singapore, 12 June 2012

¹⁹⁴ *ibid*

¹⁹⁵ Beckman and Bowles (2004) Structural Aspects of Building Conservation, Elsevier, London, p213

structural system and material, to preserve the historical fixtures and ornaments, and to extend the functional life of the bridges.¹⁹⁶

In Singapore, conservation has been an integral part of urban planning. Conservation areas, such as Singapore River, were gazetted on the basis of their architectural and townscape qualities. However, in the selection of new functions for the restored buildings, the emphasis was placed more on economical viability and less on retaining the social and cultural character of the area.¹⁹⁷ The five historic bridges, by virtue of their permanence in the riverscape, could prevent further degradation of the original urban context. The bridges had played an important role in the development of overland transportation in Singapore. Furthermore, their positions serve as “*heritage anchors*” to locate vanished trades and communities along the river.¹⁹⁸ As such, the five historic bridges should continue to be used as public bridges. Decisions to relocate, demolish or reconstruct the structures would result in an irrevocable loss in reading the river’s morphology.

As the previous chapters had shown, the planning of the early port settlement, in particular the four districts set out by Raffles’ 1823 Town Plan and the subsequent trade-driven “two harbour” system can still be identified today. The beautification and conservation of Singapore River since the 1980s has acknowledged and restored significant elements of the built environment. The colonial port is therefore an important resource in understanding the transnational trading network established by Britain in the 18th to 20th century. Furthermore, the process of importing the five historic bridges not only contributed to colonial technology transfer; it also embodied the intricate tripartite power relationships between the Colonial Government of Straits Settlements, the Crown Agents and the Colonial Office in the British Government. Such information would be of considerable significance in the historiography of colonialism, enhancing the global understanding of social and technological influences Britain had exerted on its Crown Colonies.

¹⁹⁶ Tilly (2002) *Conservation of Bridges*, Spon Press, London, p 13

¹⁹⁷ *ibid*

¹⁹⁸ Dobbs (2003) *The Singapore River, A Social History 1819-2002*, Singapore University Press, Singapore, p122

CONCLUSION

The conferment of *World Heritage Site* statuses on Melaka and Georgetown, Malaysia in 2008 recognised their importance “as former trading ports linking the East and West”.¹⁹⁹ Together with Singapore, the three port cities constituted the Straits Settlements in the 19th and 20th century. There is certainly a growing global awareness in conserving these colonial port-cities. While the historic buildings and monuments along Singapore River had been protected since 1983,²⁰⁰ the five historic bridges were only gazetted recently in 2008. The long overdue recognition acknowledged the importance of these functional structures in the historical development of river trade and overland transport. Future conservation works on the bridges would doubtlessly benefit from having a better understanding of the structural design, material and construction method of the five bridges. It remains to be seen, however, how the historic bridges could, figuratively, become *Bridges to our Heritage*. Conservation agencies should promulgate the rich historical significance of the structures as a way of showcasing the development of the old riverine town to the sprawling metropolis today.

(Fig 47)

¹⁹⁹ Melaka and George Town, Historic Cities of the Straits of Malacca, <http://whc.unesco.org/en/list/1223/>, Retrieved on 18 Aug 2012

²⁰⁰ The two areas to be preserved, The Straits Times, 6 May 1983, p1

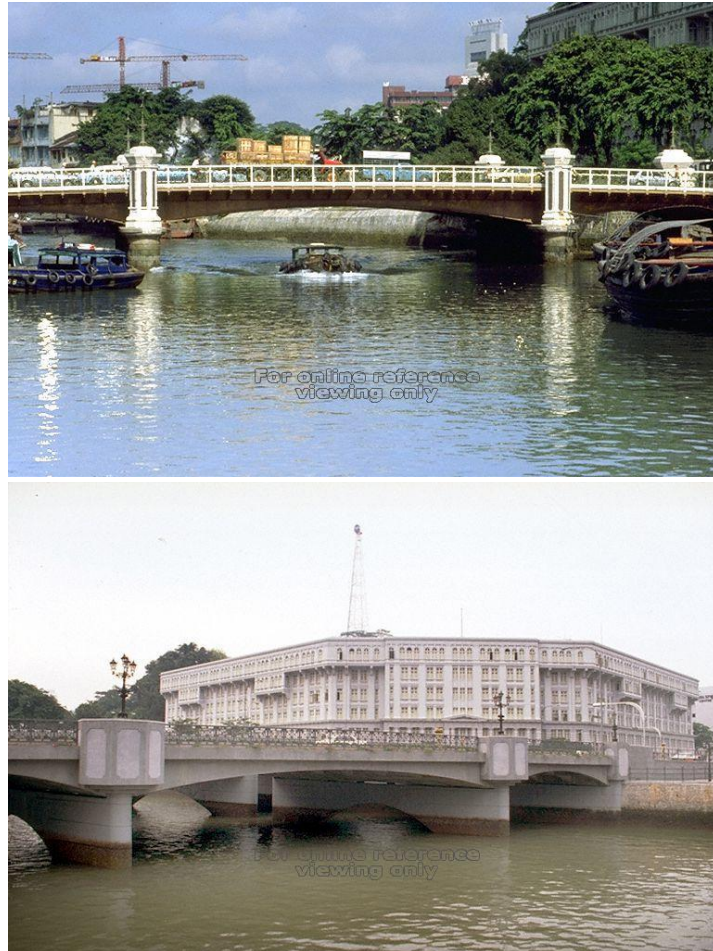


Fig 46: The demolished Read Bridge made of iron (top) and the reconstructed Read Bridge made of reinforced concrete (bottom). Note how the new bridge retained the form and details of the old bridge.



Fig 47: Anderson Bridge used as part of the F1 racing route: a way of showcasing the historic bridges for the public

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